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Systems, Science and Software, San Diego, CA

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UNITED STATES PROCEDURES FOR SAMPLING AND ANALYSIS OF HAZARDOUS WASTE

by

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of solid and hazardous wastes. These materials, if improperly dealt with, can threaten both public health and the environment. Abandoned waste sites and accidental releases of toxic and hazardous substances to the environment also have important environmental and public health implications. The Hazardous Waste Engineering Research Laboratory assists in providing an authoritative and defensible engineering basis for assessing and solving these problems. Its products support the policies, programs and regulations of the Environmental Protection Agency, the permitting and other responsibilities of State and local governments and the needs of both large and small businesses in handling their wastes responsibly and economically.

This report identifies hazardous compounds, sampling and analytical methods for measuring these compounds, and procedures that can be used to assure the quality of data obtained. This report should be useful to those who are faced with assessing the extent of hazardous compounds or determining the efficiency of control approaches.

For further information, please contact the Alternative Technologies Division of the Hazardous Waste Engineering Research Laboratory.

David G. Stephan, Director
Hazardous Waste Engineering Research Laboratory

ABSTRACT

Hazardous waste may be stored, treated and disposed in a variety of ways. Treatment technology exists today for detoxification or destruction of wastes in an environmentally acceptable manner through physical, chemical and biological means. This paper identifies hazardous compounds, sampling and analytical methods for measuring these compounds, and procedures that can be used to assure the quality of data obtained. This report should be useful to those who are faced with assessing the extent of hazardous compounds or determining the efficiency of control approaches.

CONTENTS

Foreword iii

Abstract iv

Tables vi

Figures vii

SECTION 1 1

Introduction 1

SECTION 2

Scope--Identified Hazardous Compounds 5

SECTION 3 8

Sampling Methods 8

Solids 9

Liquids 13

Gases 16

SECTION 4 24

Analysis Methods 24

Survey Analysis 30

Sample Preparation Procedures 33

Organic Constituents 34

Inorganic Constituents 38

Organic Analysis Methods 39

Monitoring 42

Inorganic Constituents 43

SECTION 5 48

Quality Assurance and Quality Control Procedures 48

REFERENCES 56

TABLES

		Page
Table 1.	Source Lists for ITD/RCRA Analytes	6
Table 2.	Choice of Samplers for Hazardous Waste	10
Table 3.	Sampling Points	11
Table 4.	Sampling Methods for Effluent Streams	12
Table 5.	Waste Evaluation Procedures	25
Table 6.	Threshold Levels of Contaminants in the Extraction Procedure Toxicity Test	28
Table 7.	Proximate Analysis of Wastes	31
Table 8.	Sample Preparation Procedures	35
Table 9.	Routine/Monitoring Organic Analytical Methods	44
Table 10.	RCRA Methods for Metal Analysis of Wastes	46
Table 11.	Essential Elements of a QA Project Plan	49
Table A.1	ITD/RCRA Compound Data	59 - 104

FIGURES

		Page
Figure 1.	Modified Method 5 Train (MM5)	20
Figure 2.	Volatile Organic Sampling Train (VOST)	23
Figure 3.	Diagram of a sampling and analysis procedure which uses replicate samples to provide information on sources of variance	54

SECTION 1

INTRODUCTION

Under the Resource Conservation and Recovery Act (RCRA), the United States Environmental Protection Agency (EPA) has promulgated proposed, interim, and final regulations for owners/operators of hazardous waste treatment, storage and disposal facilities (TSDFs) These regulations state that generators of hazardous waste are responsible from "cradle to grave" for these materials. Additionally, under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the EPA has promulgated regulations which govern the cleanup of hazardous wastes at abandoned or uncontrolled disposal sites. This law and the associated regulations provide legal mechanisms for (1) assessing actual or threatened releases of hazardous substances at uncontrolled sites, (2) implementing clean-up activities, and (3) recovering cleanup and resource restoration costs from the parties responsible for the hazardous wastes.

Key to the identification of a hazardous waste site or hazardous waste is the confirmation that specific chemical species which have been listed by EPA as hazardous are present (Ref. 1-4). This is determined by (1) prior experience of the operator/owner in knowing what is present in his wastes or (2) through specific sampling and analysis activities which quantify the concentration level of a variety of hazardous chemical constituents. To implement this latter activity, it is mandatory that specific sampling and analysis strategies are established and approved prior to implementation.

Specifically, these strategies must be designed to ensure that the data generated meets the quality requirements and intended purpose of the waste characterization effort. If a measurement activity is performed in conjunction with a hazardous waste permit program, for example, all information needed to establish compliance should be generated. As a consequence, the waste characterization strategies may vary significantly, depending upon the intended use of the information.

Clearly, the waste characterization strategy will include consideration of sampling procedures and the selection of suitable chemical analysis procedures, together with information regarding sample preservation, packaging, storage and shipping to the analysis laboratory. The strategy will also include a procedure to ensure that an effective chain-of-custody procedure is incorporated into the sampling protocol. Other important considerations include the sample size to be collected (e.g., sufficient sample must be obtained in order to make measurements in the needed concentration range). The sampling protocol will also contain explicit provisions for ensuring the safety of the personnel collecting the samples at the sampling site.

The collected raw or treated waste will be evaluated using a set of regulation-specified physical and chemical tests to determine whether it meets the definition of a hazardous waste. The owner/operator of the hazardous waste treatment, storage, and disposal facility (TSDF) first determines if his

waste is excluded in Section 261.4 or specifically listed under Subpart D of the RCRA regulation. If the waste is not excluded and not listed, then he must evaluate his waste in terms of four hazardous characteristics: ignitability, corrosivity, reactivity, and EP Toxicity, unless he can properly evaluate the waste based on his own knowledge of the waste.

The definition of hazardous waste specified in 40 CFR 261.1 for toxic constituents in the extraction procedure are in the process of expansion to cover a wide range of generally recognized toxic inorganic and organic compounds and mixtures. For hazardous waste incineration processes, for example, clear-cut regulations requiring the destruction of 99.99+ percent of the principal hazardous constituent have been defined in 40 CFR 264 (Permitting Standards) and 40 CFR 265 (Interim Status Standards). In many cases, definitive analytical methods and regulatory concentration levels have not yet been established and each waste is considered on a case-by-case basis.

The objective of this paper is to provide a management overview of the current status of procedures used in the United States for sampling the myriad of hazardous waste forms and for obtaining meaningful concentration measurements at trace and macro levels of identified hazardous compounds in the waste matrix. Detailed and generalized discussions of these methods are presented in References 1-4. This paper presents discussions on some specific and generalized analytical methods which are currently used and describes promising analytical techniques directed toward compounds for which

non-validated methods exist. Finally, information is provided on quality assurance and quality control procedures which are required to ensure that data generated are complete, representative, comparable, valid, of known precision and accuracy, and legally defensible.

SECTION 2

SCOPE - IDENTIFIED HAZARDOUS COMPOUNDS

Since 1971, the United States EPA has been identifying specific chemical compounds which are considered environmentally toxic. As a result of the 1976 Consent Decree, a comprehensive list of toxic water pollutants was generated - the priority pollutant list. In the intervening years, it has been determined that additional compounds and classes of compounds also provide a toxic concern and need to be added to the list of hazardous materials. Presented as an appendix to this paper is the most recent list; namely, the Industrial Technology Division/Resource Conservation Recovery Act (ITD/RCRA) list which defines the compounds to be analyzed in the ITD/RCRA Sewage Study project (Ref. 5). This list includes all compounds on the RCRA Appendix VIII list (40 CFR 261.33, Appendix VIII), the proposed addition to that list (Michigan Petition, 49 FR 49793, 21 December 1984), the priority pollutants, the Superfund compounds (Hazardous Substance List) the Paragraph 4C and Appendix C compounds, and additional specific compounds which are part of the class or group of compounds entered on one of the above lists. There are a total of 676 compounds or classes of compounds on this list, with considerable overlap among the source lists. Table 1 lists the number of compounds or classes of compounds identified in each of the source listings. The compounds on the source lists total 946, but when redundancies are eliminated, the total is 676.

The ITD/RCRA "list of lists" shown in the Appendix contains empirical formulas for the compounds, when possible, chemical abstract system ("CAS") registry numbers, and other unique identifying numbers when no CAS number has

been assigned, an indication of the type of analysis that is known or is probably applicable, the promulgated EPA method, when there is one, and reference to a RCRA method, when applicable. Identification of new and/or modified analytical methods is under way, and this information is being updated as methods are validated.

TABLE 1. SOURCE LISTS FOR ITD/RCRA ANALYTES

Source List	Number of Compounds	ITD/RCRA List
RCRA Appendix VIII	427	
Hazardous Substance List	128	
Priority Pollutant List	154	
Michigan Petition	121	676
Paragraph 4C	56	
Appendix C	23	
Sewage	37	
TOTAL	946	

The ITD/RCRA list of 676 compounds is clearly the most comprehensive listing of regulatory-identified hazardous compounds or classes of compounds assembled to date. An objective of the ITD/RCRA Sewage Study project is to identify and validate sampling and analytical methods which would permit quantitation of these pollutants in either trace or macro quantities in hazardous wastes. It should also be recognized that several of the 676 compounds hydrolyze or react with water, which if present in the waste

SECTION 3

SAMPLING METHODS

The sampling methods which are required for the ultimate analysis of the ITD/RCRA list of compounds in hazardous waste must be applicable to a variety of media and waste forms. Hazardous waste forms may be solid, liquid, slurry, or sludge. Hazardous waste from effluent process streams may also be gaseous or particulate-laden gases, and in this context particulate matter includes discrete particles from both solids and liquid aerosols.

The essential part of any sampling method is to assure that a sample is acquired which is representative of the waste that is being analyzed. The analytical result is only as good as the sample which has been collected. For waste that contains two phases, and ones that contain particles of varying sizes, it is essential that a means for making such a heterogeneous mixture as close to homogeneous as possible be employed. A means for agitating the waste is useful to ensure that a representative sample is acquired. Alternatively, if discrete phase layers exist within a sample, it is also possible to obtain a representative sample from each layer and then by determining the relative volume and/or weight of the layer within the waste, a calculated value of the chemical constituents in the combined separated waste can be made. In most cases, an easier prospect is to use the prior approach of mixing a heterogeneous mixture and collecting as representative a sample as possible. For

complicates their analysis. A classic example is the case of bis-chloromethyl ether, which has a half-life in water of seconds. Because of the lack of validated methods for many of the ITD/RCRA compounds, those compounds are not now being used for regulatory purposes. The "list of lists" is presented here because it shows the direction to which the EPA is moving.

TABLE 2. CHOICE OF SAMPLERS FOR HAZARDOUS WASTE

Waste Type	Sampler	Limitations/Comments
Liquids, sludges and slurries in drums, vacuum trucks, barrels, and similar containters	Coliwasa	Not for containers >1.5m deep.
	(a) Plastic	Not for wastes containing ketones, nitrobenzene, dimethylformamide, mesityl oxide, or tetrahydrofuran.
	(b) Glass	Not for wastes containing hydrofluoric acid and concentrated alkali solutions.
Liquids and sludges in ponds, pits or lagoons	(a) Dipper	Cannot be used to collect samples beyond 3.5m; dip and retrieve sampler slowly to avoid bending the tabular aluminum handle.
	(b) Weighted Bottle	May be difficult to use on viscous liquids; the bottle may also be used as the sample container.
Wastes in storage tanks	Weighted Bottle	May be difficult to use on viscous liquids; the bottle may also be used as the sample container.
Powdered or granular solids in bags, drums or containers	(a) Thief	Limited application for sampling moist and sticky solids and when the diameter of the solids is greater than 0.6 cm.
	(b) Trier	May incur difficulty in retaining a core sample of very dry granular materials during sampling.
Dry wastes (in shallow containers) and surface soil	Trowel	Not applicable to sampling deeper than 8 cm. Difficult to obtain a reproducible sample mass.
Waste piles	Waste Pile Sampler	Not applicable to sampling solid wastes with dimensions greater than one-half the diameter of the sampling tube.

Source - Reference 2

effluent streams that have good points of mixing within the pipeline, the collected proportional sample is a ready means for sample collection and assumes a homogeneous mixtures has been acquired.

The preferred method for sampling hazardous waste depends upon the exact form of the waste. Table 2 presents a summary description of general methods which are to be used for the sampling of hazardous waste. Table 2 summarizes the sampling devices appropriate for the hazardous waste sampling, and Table 3 summarizes sampling locations for most waste containers. Table 4 identifies preferred methods for sampling effluent waste streams as a function of waste type.

SOLIDS

A wide variety of sampling tools and equipment are available for the sampling of solid materials. The methods most used for sampling of solid hazardous waste are the sample corer (trier), the grain sampler (thief), and the trowel, scoop or shovel.

The trier or sample corer consists of a long tube with a slot that extends nearly the entire length of the tube. The waste pile sampler is essentially a large sample corer. These samplers are easily fabricated from sheet metal or plastic (PVC) pipe. The tip and edges of the tube slot are sharpened to allow the corer to cut a core of material to be sampled when rotated after insertion into the material. The sampler is inserted into the

TABLE 3. SAMPLING POINTS

CONTAINER	SAMPLING POINT
Drum (bung on one end)	Withdraw sample through the bung opening.
Drum (bung on side)	Lay drum on side with bung up; withdraw sample through the bung opening.
Barrels, fiberdrums, buckets, sacks, or bags	Withdraw samples through the top of barrels, fiberdrums, buckets, and similar containers, or through fill openings of bags and sacks; withdraw sample through the center of the containers and to different points diagonally opposite the point of entry.
Vacuum truck (or similar)	Withdraw sample through open hatch; sample all other hatches.
Ponds, pits, lagoons	Divide surface area into an imaginary grid;* take three samples, if possible: one sample near surface, one sample at mid-depth or at center, and one sample at the bottom; repeat the sampling at each grid over the entire pond or site.
Waste piles	Withdraw subsurface sample through at least three different points near the top of pile to points diagonally opposite the point of entry.
Storage tanks	Withdraw sample from the top through the sampling hole.
Soils	Divide the surface area into an imaginary grid;* sample each grid.

*The number of grids is determined by the desired number of samples to be collected which, when combined, will give a representative sample of the waste.

Source - Reference 2

TABLE 4. SAMPLING METHODS FOR EFFLUENT STREAMS

Waste Type	Methods
Solids	Scoops, Trowels
Liquids	Proportional Samplers, Tap Sampler
Gases	Gas Bulbs, Gas Bag Sampling, Fenceline Monitors
Slurries	Dippers, Tap Samplers
Particulate*-Laden Gases	Stack Gas Methods: Modified Method 5 (MM5) Source Assessment Sampling Systems (SASS), or Volatile Organic Sampling Train (VOST)

*Includes solids and liquid aerosols.

waste at an oblique angle to a depth established by the sampling protocol to ensure statistical representation. The sampler is rotated and then withdrawn with the open portion of the trier pointed upwards. The trier is the preferred method when powdered or granulated material to be sampled is moist or sticky. At any case, to ensure homogeneity for solid samples, cone and quartering procedures are employed to reduce the total solid waste collected down to a size manageable for analytical measurements.

Alternatively, an auger can be used to obtain samples. It is particularly useful for hard or packed solid waste or soil. An auger consists of sharpened spiral blades attached to a hard metal central shaft. To obtain samples at specified depths within a waste sample, it is usually necessary to drill down

to a specified depth and either isolate or discard the waste for the depths of no interest and then proceed to use the auger for the desired additional depth of the sample.

The grain sampler, also called a thief, consists of two slotted telescoping tubes, usually made of brass or stainless steel. The outer tube has a conical pointed tip on one end, which permits the sampler to penetrate the material being sampled. The sampler is opened and closed by rotating the inner tube. While open, the sampler is shaken to permit a free-flowing sample to fill the interior of the sampler. The grain sampler is useful for obtaining multiple samples at different depths within the free-flowing hazardous waste sample.

The trowel, scoop and shovel procedures are often used to acquire samples from conveyor belts. The laboratory scoop is similar to a trowel, except the blade on the trowel is more curved and has a closed upper lip to permit the containment of the material. An ordinary zinc-plated garden trowel can be used in some cases to sample dry, granular or powdered materials in bins or other shallow containers. The laboratory scoop, however, is a better device because it is usually made of materials less subject to corrosion or chemical reactions, thus minimizing sample contamination.

LIQUIDS

Liquid samplers that are most used for hazardous wastes include the Coliwasa, a weighted bottle (thief), a dipper, or pond sampler and a tap.

The Coliwasa is a device employed to sample free-flowing liquids and slurries contained in drums, shallow open-top tanks, lagoons, pits, and similar containers. It is especially useful for sampling waste that consists of several immiscible liquid phases. The Coliwasa consists of a glass, plastic, or metal tube equipped with an end closure that can be opened and closed while the tube is submerged in the material to be sampled. Coliwasa samples can be collected rapidly, thus minimizing exposure of the sample collector to the potential hazards of the waste. In addition, the Coliwasa sampler is simple to fabricate and inexpensive enough that contaminated parts can be discarded after a single use if the parts cannot be cleaned easily. The selection of the sampling tube material (PVC or porosilicate glass tubing) for particular waste is determined by the components of the waste (see Table 2).

To collect the waste sample, open the sampler by placing the stopper rod handle, push the rod down until the handle sits against the sampler's locking block. Slowly lower the sampler into the waste at a rate that equalizes the level of liquids outside and inside the sampler. If the level of waste in the sampler is lower inside than outside, the sampling rate would be too fast and will produce a non-representative sample. When the sampler is submerged to the desired depth or hits the bottom of the waste cylinder, push the sampler tube down to close and lock the stopper by turning the "T" handle until it is upright and one end rests on the locking block. The Coliwasa is withdrawn from the waste and wiped dry with a disposable cloth or rag. The waste sample is transferred to a storage container and the process is repeated until a

requisite quantity of sample has been collected. The use of Coliwasa is limited to sample depths less than 1.5 meters. However, this is adequate for waste containers, shallow lagoons, and drums, barrels, or tanks.

The weighted bottle sampler consists of a glass or plastic bottle, sinker, stopper and a line that is used to lower, raise and open the bottle. The weighted bottle samples liquid and free-flowing slurries from samples contained in storage tanks, wells, sumps, and other containers which cannot be sampled adequately with other liquid sampling devices. To acquire a liquid sample using a weighted bottle, the bottle is lowered to the appropriate depth, uncapped, and after completely filled the sample is withdrawn. Once out of the waste, the bottle is capped, rinsed off, and used as a sample storage container. The sampler cannot be used to collect liquids that are incompatible with or chemically react with the weight sinker or the control lines.

The dipper or pond sampler consists of a glass or plastic beaker clamped to the end of a two- or three-piece telescopic aluminum or fiberglass pole (which serves as a handle). The dipper samples liquids and free-flowing slurries from ponds, pits, tanks with open tops, and lagoons. Dipper samples are collected from open streams such as sluices, or from open tanks where there is sufficient access to permit the insertion and removal of the dipper. The sample is collected by inverting the beaker and insertion of the pole into the waste liquid or slurry at an oblique angle. At the appropriate depth, the beaker is turned right-side up and allowed to fill completely, as evidenced by the cessation of air bubbles at the top surface of the waste. The dipper is raised and the sample is transferred to an appropriate storage container.

Tap sampling is the appropriate method for sampling liquid wastes in static or effluent pipes or ducts. Coliwasa sampling is not appropriate to the collection of liquids from moving streams. For liquids in motion, such as industrial discharges or scrubber waste mixtures, a tap either in the process line or in the storage reservoir permits acquisition of a representative sample. Commercial proportional samplers are often used to open and close valves periodically and provide a time-averaged sample. In this method, a tap is attached to the waste stream line and a portion of the flowing liquid is diverted into a sampling bottle. When sampling non-volatile liquid products, the sampling apparatus should be filled and allowed to drain before acquiring the actual sample. If the actual sample is to be transferred to another container, the sample container should be rinsed with some of the product to be sampled and drained before it is filled with the actual sample. A proportional sampler usually provides this rinsing operation automatically.

GASES

Hazardous waste gases are collected by a variety of techniques, depending if they are from a static or flowing source. For static gases, it is first necessary to know the pressure within the container. Hazardous high-pressure gas under static conditions is sampled by allowing the gas to blow down into either an evacuated vessel or a gas bag sampling system.

For gas bulb sampling, a glass bulb is evacuated prior to connection to the sample line. The gas bulb is connected to the a valve on the container to be sampled, and usually the volume between the tank valve and the gas sampling

valve is evacuated. The gas storage tank valve is opened and then the gas sampling bulb valve is carefully cracked open and allowed to fill to approximately 1 atm. A manometer is used to ensure that this pressure is not exceeded. If a corrosive gas is sampled, the pressure measuring device contact surface must be chemically compatible with the toxic gas. It is important to not let the glass bulb pressure exceed 1 atm when sampling a high-pressure gas source because the high pressure could fracture the glass or blow out the valve stopcocks and hence lose the sample.

For low-pressure hazardous gas samples (less than one atmosphere pressure), the evacuated bulb is connected to the vessel and the volume between the two valves is evacuated. Then the tank is opened and the sampling bulb is opened and allowed to equilibrate at a reduced pressure. In this instance, however, if it is seen that any liquid in the gas chamber begins to froth, indicating volatilization of additional liquid, the sampling should terminate and the pressure of the storage container and the glass bulb should not be equilibrated; a non-representative sample of the gas above the liquid could result if it were a mixture of liquid waste compounds. Once the bulb is filled, the sample valve is closed and firmly sealed. The bulb is removed and shipped to the laboratory for analysis. It is desirable to have the glass gas bulb to be contained in a box having an outer styrofoam jacket to provide thermal insulation during handling and for sample safety during shipping.

For <u>gas bag sampling</u>, a non-reactive probe is attached to the high-pressure hazardous gas container with a bag in the deflated position. The tank is opened and the gas is bled into the gas bag, which is allowed to

inflate. Gas bags are usually made of Tedlar, which has been shown to be compatible with most hazardous gas samples collected from the environment or from effluent combustion streams. However, gas bag sampling should only be used for those chemical constituents for which it is validated. Also, it is important that field blank gas bag samples are collected at the same time that the field samples are acquired.

Fenceline monitoring systems are often used to acquire gaseous samples which are emitted from open and closed hazardous waste storage areas and to acquire fugitive emissions from industrial plants. Typically, these sampling systems consist of Tenax and/or XAD-2 sorbents through which the sample is collected by a small pump which collects and concentrates the sample over an extended period of time. The trap/sorbent module is sealed and it is sent to the laboratory for detailed analysis. For gaseous inorganic hazardous constituents, charcoal, and in some cases, impingers filled with reactive scrubbing solution are used to collect specific hazardous gases.

For flowing gases such as that in incinerator combustion stacks or from sources such as fossil fuel combustors, several detailed sampling trains have been specified by EPA to ensure collection of representative samples of the gas and particulate matter that may be present in this complex mixture. These methods are used for regulatory purposes to ensure that an incinerator, for example, does its intended job of removing 99.99% of the principal organic hazardous constituents (POHCs) in the hazardous waste. During trial burns, for example, the measurement of POHCs in the stack gas effluent is an integral

part of the calculation of the destructive and removal efficiency (DRE) values to determine whether the incinerator meets its performance criteria. Similarly, flue gas desulfurization control processes are sampled by these procedures to ensure that regulatory removal efficiencies of sulfur in the fuel are achieved.

In general, the sampling of a stack gas is the most important part to determining whether regulatory limits have been achieved. The sampling apparatus consists of three major components:

- An extraction probe which must be resistant to the physical and chemical reactions of the gas being sampled,
- One or more thermostatted compartments to maintain the gas at temperatures consistent with the collection medium, usually hot (greater than 200°C) for particulate collection, and cool (less than 20°C) for sorbent collection of the more volatile constituents, and
- The sample collector.

The three major stack gas sampling trains for measurement of emissions are:

- The Modified Method 5 train (MM5),
- The Source Assessment System (SAS), and
- The Volatile Organic Sampling Train (VOST).

In addition, gas bulb and gas bag sampling systems have often been used.

The Modified Method 5 (MM5) sampling train is based on the design of units which are used for sampling under EPA Method 5 (Ref. 6). The modified system (Ref. 2) consists of a probe, an optional cyclone, a high-efficiency glass or quartz fiber filter stage, a sorbent module, four impingers, and some control hardware. A diagram of this system is shown in Figure 1. The Method 5 procedure has been modified by including a sorbent module which permits trapping of volatile organic vapors and is mounted vertically atop the first impinger of the train. The first impinger is empty and is used to collect the condensate which percolates through the sorbent train module. Details of the operation of this train for use in sampling hazardous waste combustion products are described in Reference 2.

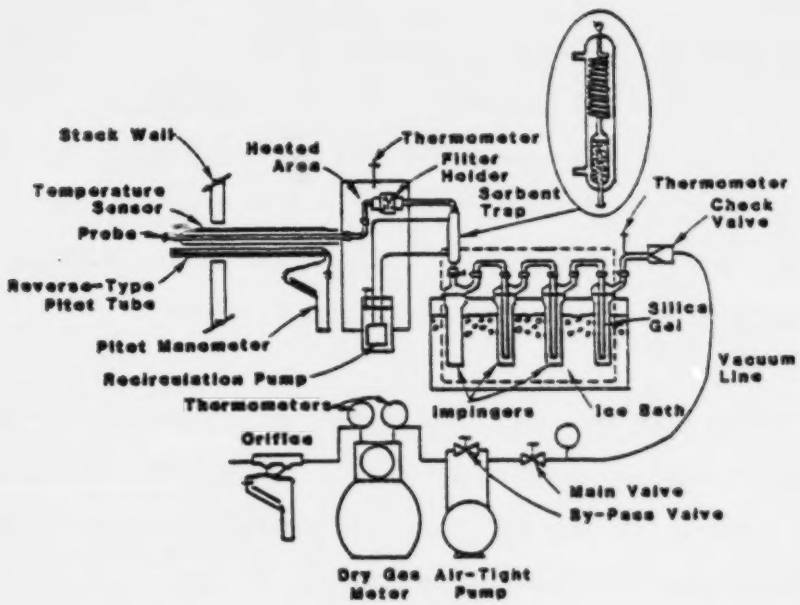

Figure 1. Modified Method 5 Train (MM5)

By careful control of the temperatures within the train, organic combustion products and POHCs are collected in the sorbent module. Typically, the sorbent module is filled with XAD-2 resin, a porous polymer capable of absorbing a broad range of organic chemical species. This sorbent module provides efficient collection of vapor-phase organic materials with boiling points >100°C. An oversized impinger is placed just below the sorbent module to collect high-moisture streams for subsequent organic analysis. The second impinger is a modified version of the Greenburg-Smith design filled with scrubbing solution. The selection of the scrubbing solution depends on the type of vapors that are suspected of being contained in a stack gas. A caustic solution such as sodium hydroxide or sodium acetate is used to collect acidic gases such as HCl. For collecting volatile metals, such as mercury, arsenic or selenium, a strongly oxidizing solution such as silver catalyzed ammonium persulfate must be employed. The third impinger is a Greenburg-Smith impinger with a tip with an appropriate scrubbing solution. The fourth impinger is typically filled with silica gel to absorb any moisture in the stack gas. Moisture removal is important to ensure accurate gas flow measurements and to prevent damage to the pumping system.

The Source Assessment Sampling System, first utilized in 1972, is an alternative integrated stack gas sampling system. It is essentially a five-fold scale-up of the MM5 train and collects a larger sample, which permits measurement of lower concentrations of trace-level emissions. In addition, the SASS train also incorporates three cyclones and a filter in an oven module to permit large collection capacities for particulate matter

nominally size classified into three ranges: >10μm, 3μm to 10μm, and 1μm to 3μm. By means of a standard 142-mm or 233-mm filter, a fourth cut less than 1μm can also be obtained. This system is usually used more for industrial sources when particularly dirty particulate emissions are generated.

In 1982, a new sampling train, the Volatile Organic Sampling Train (VOST), was developed and tested and shown to be most effective in determining volatile hazardous constituents in incinerator effluents. This system was developed as an alternative to the use of the integrated gas bag sampling device or the gas bulb sampling system for the collection of volatile POHCs. A schematic diagram of this train is shown in Figure 2. In this system, the first trap contains Tenax absorbent, which is preceded by a gas cooler/condenser and followed by an impinger for condensate collection. A second trap, containing a section of Tenax and a section of charcoal absorbent, is located after the impinger. The purpose of the second trap is to collect very volatile compounds which readily break through the initial Tenax trap. The method for use of the VOST also requires replacing both pairs of traps with fresh traps every 20 minutes (when a 1-L/min flow rate is employed over a two-hour sampling period for a total of six pairs of traps). The serial collection of several pairs of traps assures that the more volatile components will not pass through both the first Tenax trap and the Tenax/charcoal trap. The six pairs of traps are usually combined for subsequent desorption and analysis.

As discussed earlier, it is essential to collect representative samples for analysis. For the sampling of physical forms of solids, liquids, gases,

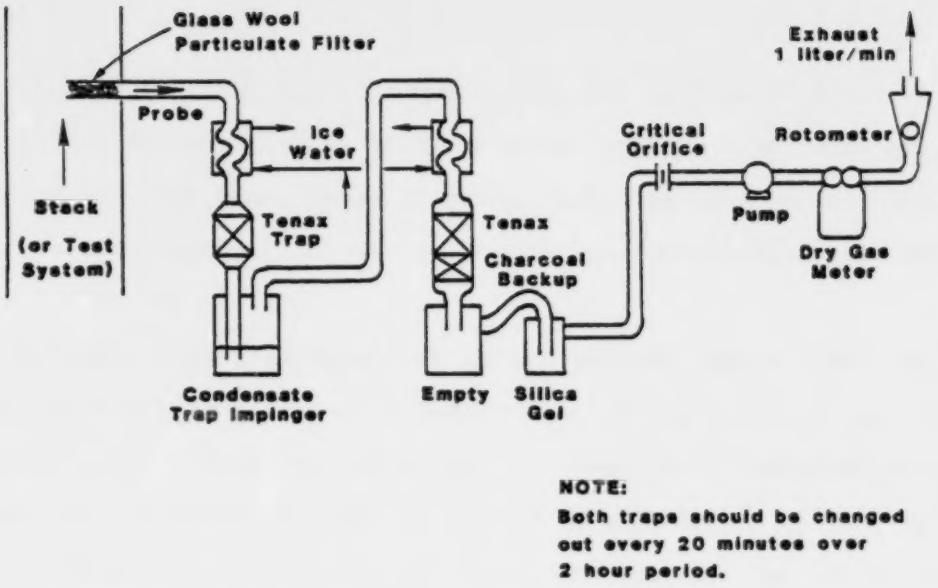

Figure 2. Volatile Organic Sampling Train (VOST)

and combinations in slurries, sludges, and particulate-laden gases, specific sampling protocols usually provide for acquiring representative samples. After a sample has been acquired and transferred to the proper sample container, the container must be tightly capped as quickly as possible to prevent loss of volatile components and to exclude possible oxidation from the atmosphere. In general, samples of organic hazardous waste are stored in glass containers and samples of hazardous metals are stored in plastic containers. Organic samples are usually stored at 4-6°C to preserve their chemical composition. Water samples used for metal analyses are usually preserved with nitric acid, depending on the metals of question. A discussion of sampling and sample preservation of hazardous materials in water and wastewater is provided in Reference 7, dealing with industrial wastewater, municipal wastewaters, agricultural discharges, surface water, sludges, and suspended solid samples.

SECTION 4

ANALYSIS METHODS

As mentioned briefly in the introduction, the RCRA regulations require that a waste to be identified as "hazardous" must have at least one of the following four characteristics:

(1) Ignitability,

(2) Corrosivity,

(3) Reactivity, and/or

(4) EP Toxicity

The methods used to classify a waste for these four characteristics and the criteria employed are summarized in Table 5. Detailed procedures for these measurements are given in Test Methods for Evaluating Solid Waste - Physical/ Chemical Methods, SW-846 (Ref. 1). These procedures are used to determine whether the wastes exhibit the characteristics of a hazardous waste as defined by Section 3001 of RCRA.

The objective of the Ignitability Characteristic is to identify wastes that are either present fire hazards under routine storage, disposal and transportation, or are capable of severely exacerbating a fire once started. A solid waste is considered to exhibit the characteristic of ignitability if a representative sample of the waste has any of the following properties:

TABLE 5. WASTE EVALUATION PROCEDURES

CHARACTERISTIC	METHOD/CRITERIA
IGNITABILITY	1. Flash Point <60° - • Pensky Martens Closed Cup (RCRA 1010), or • Setaflash Closed Cup (RCRA 1020)
CORROSIVITY	1. pH ≤2 or ≥12.5 - RCRA 940, or 2. Corrodes SAE 1020 Steel >6.35 mm/yr - RCRA 1110
REACTIVITY	Professional Judgement: • Undergoes violent chemical changes, • Reacts violently with H_2O or forms potentially explosive mixtures with H_2O, • Generates toxic fumes with H_2O, or in the case of cyanide or sulfide wastes when exposed to mildly acidic or basic conditions, • Explodes at normal temperatures and pressures, or when subjected to a strong initiating force or at elevated temperature, or • Is a DOT Class A or Class B Explosive.
EP TOXICITY	Waste extract composition exceeds any of 14 specific chemical concentration levels (8 metals, 4 pesticides and 2 herbicides); Extraction Procedure (EP) defined in RCRA 1310; Metal Methods 7060, 7080, 7130, 7190, 7420, 7470, 7740, and 7760; Pesticides 8080; and Herbicides 8150.

- It is a liquid other than an aqueous solution, containing less than 24 percent alcohol by volume and has a flash point of less than 60°C.
- It is not a liquid but is capable, under standard temperature and pressure, of causing fire through friction, adsorption of moisture, or spontaneous chemical changes, and, when ignited, burns vigorously.
- It is an ignitable compressed gas; or
- It is an oxidizer.

The objective of the Corrosivity Characteristic is to identify wastes which might pose a hazard to human health or to the environment because of its ability to:

- Mobilize toxic metals if discharged into a landfill,
- Corrode handling, storage, transportation, and management equipment, or
- Destroy human or animal tissue in the event of inadvertent contact.

Solid waste is considered to exhibit the characteristic of corrosivity if a representative sample has either of the following properties: It is aqueous and has a pH ≤ 2 or ≥ 12.5; or is a liquid and corrodes steel at the rate of >6.35 mm/year at a test temperature of 55°C.

The Reactivity Characteristic of a hazardous waste defines a reactive waste as one having any of the following properties:

- Readily undergoes violent chemical change,
- Reacts violently or forms potentially explosive mixtures with water,

- Generates toxic fumes when mixed with water, or in the case of cyanide- or sulfide-bearing wastes when exposed to mild acidic or basic conditions.
- Explodes when subjected to a strong initiating force,
- Explodes at normal temperatures and pressures, or
- Fits within the Department of Transportation's Class A or Class B Explosive classification.

Reactivity is determined by applying the best professional judgements to the available data. There are no explicit experimental test procedures for determining this characteristic.

The Extraction Procedure Toxicity Characteristic is determined by a test designed to simulate the leaching a waste will undergo if disposed of in an improperly designed sanitary landfill. This laboratory test consists of extracting a representative sample of waste with distilled water maintained at a pH of 5 using acetic acid. The extract obtained from the EP (the "EP Extract") is then analyzed to determine if any of the thresholds established for the eight elements (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), four pesticides (endrin, lindane, methoxychlor, toxaphene), and two herbicides (2,4,5-trichlorophenoxypropionic acid, 2,4-dichlorophenoxy-acetic acid) have been exceeded. If the EP extract contains any one of the above substances in an amount equal to or exceeding the levels shown in Table 6, the waste is considered to possess the characteristic of extraction procedure toxicity and is a hazardous waste.

TABLE 6. THRESHOLD LEVELS OF CONTAMINANTS IN THE EXTRACTION PROCEDURE TOXICITY TEST

Contaminant	Threshold Level (mg/L)	RCRA Method
Metals		
Arsenic	5.0	7060
Barium	100.0	7080
Cadmium	1.0	7130
Chromium	5.0	7190
Lead	5.0	7420
Mercury	0.2	7470
Selenium	1.0	7740
Silver	5.0	7760
Pesticides		
Endrin	0.02	8080
Lindane	0.4	8080
Methoxychlor	10.0	8080
Toxaphene	0.5	8080
Herbicides		
2,4-Dichlorophenoxyacetic acid	10.0	8150
2,4,5-Trichlorophenoxypropionic acid	1.0	8150

In the extraction procedure, a waste containing unbound liquid is filtered and if the solid waste is less than half a percent of the waste, the solid phase is discarded and the filtrate analyzed for trace elements, pesticides and herbicides. If the waste contains more than 0.5 percent solids, the solid phase is extracted and the liquid phase stored for later use. Prior to extraction, the solid material must pass through an 0.5-mm standard sieve. If the waste consists of a single piece, it must be subjected to the structural integrity procedure (SIP), which is used to demonstrate the ability of the waste to remain intact after disposal. If the waste does not meet one of these conditions, it must be ground to pass a 9.5-mm sieve. After extraction, the liquid:solid ratio is adjusted to a 20:1 v/v and the resulting liquid extract is separated by filtration. The solid is discarded and the liquid extract is combined with any filtrate obtained during the initial separation.

Currently, the EPA Office of Solid Waste is examining an alternative procedure called the Toxicity Characteristic Leaching Procedure (TCLP), which uses a zero headspace extractor and generates analysis samples for volatile and semi-volatile organic constituents, pesticides, and metal species. This new procedure is undergoing interlaboratory validation prior to publication for public comment.

SURVEY ANALYSES

The hazardous waste characteristics have been stipulated as regulatory requirements. Often, it is desirable to obtain survey information regarding a hazardous waste in order to guide the detailed characterization of specific chemical species in the waste. The survey information often consists of proximate analysis of the waste, as well as survey analyses of organic and inorganic species.

Proximate analysis includes determination of physical properties such as moisture, solid, and ash content, as well as determination of such chemical properties as the total organic carbon, total organic halogen, elemental composition, viscosity, and heating value of the waste. This latter parameter is particularly important when the waste is to be considered for disposal by incineration techniques. These methods are listed in Table 7. Proximate analysis provides the data relating to the physical form of the waste and provides an approximate mass balance of its composition. This information meets the waste analysis requirement of 40 CFR 264, Subpart O regulation, and is also responsive to the general waste analysis requirements of Subpart B. The elemental composition data allow prediction of a high concentration of potentially significant hazardous compounds. These data also facilitate an informed selection of the hazardous constituents that might be present or not present in the waste.

TABLE 7. PROXIMATE ANALYSIS OF WASTES

Characteristic	Method
Moisture Content	Loss to constant weight on oven drying at 103°C for one hour.
Solids Content	Calculated as residual weight after oven drying.
Ash Content	Solid residue after ignition of sample at 600°C for 30 minutes.
Elemental Composition	Determined by standard microchemical Pregl train methods
Total Organic Carbon	TOC Analyzer measures CO_2 and CH_4 on combustion of sample.
Total Organic Halide	TOX Analyzer measures acid halides formed during combustion of sample.
Viscosity (of liquids)	Kinematic (Ostwald) Viscometer at constant temperature.
Heating Value	Adiabatic bomb calorimetry.

Survey chemical analyses are designed to provide an overall description of the sample in terms of (1) the major types of organic compounds, and (2) the major inorganic elements (metals) that are present. The survey analysis package includes determination of:

- Total organic content by chromatographic (TCO) and gravimetric (GRAV) procedures,
- Organic compound class types present by infrared (IR), and probe mass spectrometric procedures,

- Major organic components by gas chromatography/mass spectrometric (GC/MS) or high performance liquid chromatographic/infrared (HPLC/IR) or high performance liquid chromatographic mass spectrometric (HPLC/MS) procedures, and
- Metals by inductively coupled argon plasma emission spectroscopic (ICAP) and atomic absorption spectroscopic (AAS) procedures.

The type and data generated by survey analysis provides a qualitative description of the overall chemistry of the sample. This information is important in deciding which of the hazardous constituents in the ITD/RCRA list are present in the waste, and may lead to the prediction and/or identification of alternative, previously unsuspected constituents in the waste.

In recent years, the use of survey analysis procedures has diminished significantly because of major enhancements in the capillary column gas chromatographic/mass spectrometric/data system (CCGC/MS/DS) techniques and the use of specific stable labeled internal standards. The use of improved data system target compound search computer software has also significantly improved and its cost has diminished so that often analysts prefer to go directly to a quantitative/semi-quantitative procedure without employing a survey method. In addition, the use and application of HPLC, improved detection systems and ICAP have also improved markedly so that it is more cost-effective to go directly to the direct compositional analysis. The reader is referred to Reference 2 for additional details regarding the use and application of the survey methods.

SAMPLE PREPARATION PROCEDURES

Samples collected in the field usually must be treated by a series of special techniques to permit their conversion into a matrix which is compatible with the final analysis methods needed for measurement of the specific hazardous constituent. The techniques vary significantly and depend on whether the hazardous species under question is organic or inorganic in nature, and the nature of the waste itself, whether a gas, liquid, or solid. The sample preparation scheme for analysis of the organic components may require extraction of the sample, concentration of an extract, and/or the cleanup of a sample extract to remove potential interferences. Surrogate and standard addition methods are often used to facilitate quantitation, determine the degree of recovery of the species in question from the matrix, and provide information regarding the precision and accuracy of the resulting data. Digestion of a sample is necessary prior to the analysis of metal inorganic constituents. For aqueous wastes, it is not necessary to digest the sample for metal or anion analyses.

The sample preparation method often depends on the final desired analytical method of choice. In general, because of the high sensitivity/selectivity of fused silica capillary column GC/MS, this procedure is generally the analytical procedure of choice. Because of its wide applicability and generally good quantification capability, this method has been selected by EPA's Office of Emergency and Remedial Response as the primary procedure for characterization of organic constituents in hazardous wastes (Ref. 8). In their procedures, the sample preparation technique is

relatively simple and straightforward. However, if other procedures, such as packed column gas chromatographic methodology with specific detectors other than mass spectrometry are employed, often other clean-up techniques are required to remove potential interfering compounds which could cause confusion in the characterization of the specific target chemical compound. The generally used sample preparation procedures are delineated in Table 8 and are discussed below.

ORGANIC CONSTITUENTS

Liquid/liquid extraction is the primary method used to extract non-volatile and semi-volatile organic compounds from liquid samples. Liquid/solid extraction is used to extract these compounds from solid samples. Methylene chloride is the preferred low-boiling solvent used to extract aqueous materials using either separatory funnels (RCRA 3510) or continuous liquid/liquid extractors (RCRA 3520). The continuous liquid/liquid extractor is advantageous compared to the separatory funnel method because it minimizes the formation of emulsions and can be performed with minimum labor.

The classes of organic compounds in aqueous-based waste are separated by regulating the pH of the aqueous phase prior to extraction with methylene chloride. Sample preparation for the pesticide/PCB constituents in aqueous wastes are accomplished by extraction with methylene chloride of a sample that has been treated to be neutral (acidity between pH 5 and 9). Separately, sample preparation for extractable base/neutral and acid fractions are

TABLE 8. SAMPLE PREPARATION PROCEDURES

Constituents	Method
Inorganic:	
Acid Digestion	RCRA 3010; HNO_3 digestion of sample; dissolve digestate in 1:1 HCl.
	RCRA 3020; HNO_3 digestion of sample; dissolve digestate in 0.5% v/v HNO_3.
	RCRA 3030; Digestion of samples containing oils, greases, or waxes using H_2SO_4, HNO_3, and H_2O_2.
	RCRA 3050; HNO_3/H_2O_2 digestion of sludges; digestate is solubilized with either HCl or HNO_3.
Organic Solvent Dissolution	RCRA 3040; Use xylene or methyl isobutyl ketone to dissolve oils, grease or wax samples; organometallic standards are used.
Alkaline Digestion	RCRA 3060; Digestion of sample with Na_2CO_3 and NaOH to determine Cr^{+6}.
Organic:	
Liquid-Liquid Extraction	RCRA 3510; Adjust pH, extract with methylene chloride using separatory funnel; obtain three fractions A/B/N; dry with Na_2SO_4 and concentrate.
	RCRA 3520; Alternative to RCRA 3510, but uses a continuous extractor.
Soxhlet Extraction	RCRA 3540; Soxhlet extraction of soils/sludges; extract is dried and concentrated; methylene chloride ether, acetone/hexane, and benzene/methanol common extraction solvents.
Sonication Extraction	RCRA 3550; Alternative to RCRA 3540, but uses sonication to solubilize sample.
Purge and Trap	RCRA 5030; Volatile organic species are separated from sample by purging with He and sorbed on Tenax sorbent; sorbent is then heated, backflushed with He onto GC column.
Head Space	RCRA 5020; Ullage volume of waste container is sampled using a gas syringe and injected into GC.

accomplished by adjusting a measured volume of the sample, first to a pH greater than 11 and then extracting with methylene chloride, and then adjusting the acidity of the aqueous phase to a pH less than 2 and extracting it with a separate second portion of methylene chloride. The methylene chloride extracts are generally concentrated and dried by treatment with anhydrous sodium sulfate and concentrated using a Kuderna-Danish methodology to a final volume of 1.0 mL (Ref. 8).

Surrogate standard spiking solutions and base/neutral acid matrix standard spiking solutions are employed to permit calculation of (1) the aqueous soil surrogate percent recoveries, (2) the matrix spike and matrix spike duplicate percent recovery results, and (3) the relative percent difference between duplicate analyses. A method blank is run concurrently using an equivalent volume of deionized distilled laboratory water for water samples, or a purified solid matrix for soil/sediment samples carried through the entire analytical scheme of extraction, concentration and analysis. The method blank volume or weight must be approximately equal to sample volumes or sample weights being processed. Surrogate standard determinations are performed on all samples and blanks.

All samples and blanks are fortified with surrogate spiking compounds before purging or extraction in order to monitor preparation and analysis of samples. In order to evaluate the matrix effects of the sample upon the analytical methodology, the USEPA has developed standard mixes to be used for matrix spikes and matrix spike duplicate analyses. The surrogate spike method

blank and matrix spike duplication analyses are used as quality assurance procedures to ensure that the data generated are complete, representative, comparable, valid, of known precision and accuracy, and legally defensible.

The CERCLA regulatory procedure for preparing soil samples consists of ultrasonic extraction of dried soils/solids with methylene chloride after surrogate standards are added to all samples, spikes and blanks. A matrix standard spiking solution is added to two 1-gm portions of the sample chosen for spiking. After sonication for two minutes at 100-watts power with pulse set at 50 percent, the methylene chloride extract is separated from the soil by filtering through glass wool and then concentrated to a final volume of 1 mL by a nitrogen blow-down technique.

Purgeable (volatile) organic compounds in these samples are first screened on a gas chromatographic/flame ionization detector (GC/FID) to determine the approximate concentration of organic constituents in the samples. The actual sample preparation is based on a purge and trap method (RCRA 5030). For the sediment/soil samples, the purge device is heated. For water samples, an inert gas is bubbled through a 5-mL sample contained in a specifically designed purging chamber at ambient temperature. The purgeable constituents are efficiently transferred from an aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and backflushed with an inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature programmed to

separate the purgeables which are then detected with a mass spectrometer. For sediment/soil samples, an inert gas is bubbled through a mixture of a 5-g sample and reagent water contained in an especially designed purging chamber maintained at elevated temperatures.

For some samples, the level of interfering compounds is sufficiently high to preclude successful analysis of the analytes of interest. For these samples, one or more clean-up steps should be considered to facilitate the final analysis step. Clean-up methods such as size exclusion chromatography, liquid column chromatography, using columns filled with silica gel, Forisil, activated alumina, charcoal, etc.; solvent partitioning and filtration may be used alone or in combination to cleanup the samples for analysis. A common solvent partitioning technique, used for the cleanup of polychlorinated biphenyl compounds consists of treating the sample with a mixture of concentrated sulfuric acid and hexane. In this case, the PCBs are partitioned into the hexane layer and aqueous constituents and many organic compounds are retained in the sulfuric acid layer by reacting with the sulfuric acid and forming a sulfuric acid soluble product.

INORGANIC CONSTITUENTS

Preparation procedures for all wastes containing metals include a digestion step unless it is an aqueous waste and can be used directly. The digestion procedures, RCRA Methods 3010, 3020, 3030, and 3050, are acid digestions, with varying degrees of acid strengths and oxidizing capabilities.

Alternatively, oils, grease and waxes can be solubilized, often using xylene or methyl isobutyl ketone as solvents. In this case, organometallic standards are used for the metallic species. In the special case of determining the amount of chromium in the +6 valence state, alkaline digestions are employed, using basic carbonate media.

ORGANIC ANALYSIS METHODS

The EPA Superfund (CERCLA) regulatory procedures consist of using a comprehensive capillary column gas chromatographic/mass spectrometric/data system technique for characterizing a wide range of analytes (Ref. 8). This has been proven to be the most cost-effective way to characterize a wide range of analyte chemical classes. As discussed in the sample preparation section, the wastes are isolated into four separate fractions by extraction and purge and trap techniques. These fractions, the pesticide fraction, the acid fraction, the base/neutral fraction, and the volatile organic constituents (VOCs) fraction are analyzed by capillary column gas chromatographic/mass spectrometric/data system (CCGC/MS/DS) techniques.

The CCGC/MS/DS method is extremely powerful because it can provide both qualitative and semi-qualitative results. The mass spectrometer used must be capable of scanning from 35 to 500 amu every one second or less, utilizing 70 volts nominal electron energy in the electron impact ionization mode and producing a mass spectrum which meets all the requirements and criteria when 50 ng of decafluorotriphenylphosphine (DFTPP) is injected through the GC inlet. A computer data system must be interfaced with the mass spectrometer

that allows continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that allows searching any GC/MS data file for ions of specific mass and plotting such ion abundances versus time or scan number. This type of plot is defined as an extracted ion current profile (EICP). Software must be available that allows integrating the abundance in any EICP between specified time or scan number limits.

A key factor in the use of computerized mass spectra search systems is the data base. Tentative identifications are obtained from the GC relative retention time information and the examination of specific mass spectra for the individual gas chromatographic peak of either a pure compound or certainly a limited number of compounds, and comparison with the data base usually provides unequivocal characterization of the compounds. The computerized reverse-search systems have been enhanced so that a series of target compounds can be identified with search routines requiring less than three seconds per target compound (e.g., a search of 100 compounds in less than five minutes).

Algorithms for goodness-of-fit parameters and the values associated with specific levels of confidence in the identification vary, depending upon the particular software employed. For this reason, it is essential to also use the professional judgement of the mass spectroscopist to verify that all compound identifications are accurate.

Since 1980, the use of stable labeled surrogates as internal standards in combination with the CCGC/MS/DS characterization of pollutants has been a further significant enhancement of the analysis of samples containing hazardous compounds. In this method, the stable labeled analog behaves chromatographically identical to the target compound; however, its mass spectrum is clearly distinguishable from the non-labeled compound in the sample. In EPA Methods 1624 and 1625 (Ref. 9), a total of 32 and 65 specific stable labeled isotopes, respectively, are used in an isotope dilution mode as internal quantitation standards. This approach has resulted in enhanced precision and accuracy of analysis; it has also been determined that the calculated percent recoveries using isotope dilution are uniformly unaffected by the sample matrix. The availability of stable labeled analyte standards has increased significantly since its initial examination for pollutant analysis purposes. The commercially available useful stable labeled compounds has grown from 36 to over 107, and it appears that additional compounds will be available to support the analysis of many of the pollutants listed in the ITD/RCRA list (see Appendix).

Detailed CCGC/MS/DS procedures for the analysis of chlorinated dibenzo-p-dioxins and dibenzofurans are given in RCRA Method 8280 (Ref. 10). This method utilizes an analytical extraction clean-up procedure, a CCGC/MS/DS method and ^{37}Cl stable labeled internal standards. If interfering substances are still present after the initial clean-up steps, the analyses are separated from the interferences using an HPLC clean-up procedure.

Many of the high-molecular weight, non-CCGC separable compounds listed in the Appendix can be analyzed by high-performance liquid chromatography (HPLC). This method uses specific hardware consisting of reservoirs for the elution solvent(s) which may have a system for blending two solvents using a gradient mixing device, pumps, injection port, columns, detection, and read-out devices, and thermostats for the column and detector. These components are commercially available as individual modules or for incorporation into a complete HPLC systems. The most common HPLC detectors utilize ultra-violet absorption or fluorescence emission at a single wavelength. Polynuclear aromatic hydrocarbons are often analyzed by HPLC methods when those are the primary constituents in the waste (RCRA Method 8310).

Another analytical method that is receiving considerable interest in analyzing complex mixtures is one of liquid chromatography/mass spectrometry. In this case, a separation of non-volatile materials occurs by liquid chromatography and then a thermospray injection technique is used for introduction of the liquid compound into the mass spectrometer. This advanced methodology is currently under considerable research at the present time. It is believed that some analytical procedures for specific compounds will be recommended for use in the near future.

MONITORING

For many hazardous wastes generated routinely in industrial operations, or where the waste is relatively well known, monitoring techniques can be most useful. In this case, the high-resolution, comprehensive capability of the

CCGC/MS/DS is not required and less sophisticated and less costly methods, such as packed column gas chromatography with specific detector capabilities, can be employed successfully. These methods were initially tested and validated for use in characterizing organic wastes in wastewaters, surface waters and industrial discharges to satisfy the Clean Water Act requirements and the National Pollution Discharge Elimination System (NPDES). Procedures commonly used for monitoring organic constituents after use of specific clean-up methodology are listed in Table 9.

INORGANIC CONSTITUENTS

Inorganic constituents of wastes are categorized as metal or metal-containing, anion-containing, or gases. Metal-containing species in wastes are usually analyzed by atomic absorption spectroscopy (AAS) or inductively coupled plasma emissions spectroscopy (ICAP) techniques. Two modes of analysis are used for these species; direct analysis from solution, or coal vapor/hydride evolution. The choice of analysis technique depends upon the specific metal of interest and required detection sensitivities.

For all the metals, except arsenic, selenium, and mercury, the solution resulting from the digestion preparation procedure may be aspirated directly into the flame AAS or into the plasma for ICAP, or injected directly into the furnace for flameless AA analysis at a wavelength which is specific to the element under investigation. The spectrometer is adjusted so that only the specific wavelength(s) of interest are detected at the photomultiplier detector. The amount of absorption or emission which occurs during the AAS or ICAP experiment is directly related to the concentration of the metal present.

TABLE 9. ROUTINE/MONITORING ORGANIC ANALYTICAL METHODS

Organic Species	Method
Halogenated Volatile Compounds	RCRA 8010-Purge and trap injection into packed column GC/ECD
Volatile Organic Compounds	RCRA 8015-Purge and trap injection into packed column programmed GC/FID
Volatile Aromatic Compounds	RCRA 8020-Purge and trap injection into packed column programmed GC/FID
Acrolein, Acrylonitrile, Acetonitrile	RCRA 8030-Purge and trap injection into packed column programmed GC/FID
Phenols	RCRA 8040-Methylene chloride acid extracted samples are injected into packed column using FID; alternative incorporates PFB derivation and ECD
Phthalate Esters	RCRA 8060-$MeCl_2$ neutral extraction, clean up, isothermal packed column GC/FID
Organochloride Pesticides & PCBs	RCRA 8080-$MeCl_2$ neutral extraction, clean up, isothermal packed column GC/ECD
Nitro aromatic compounds and Cyclic ketones	RCRA 8090-$MeCl_2$ neutral extraction, clean up, isothermal packed column GC and either FID or ECD
Polynuclear Aromatic Compounds	RCRA 8100-$MeCl_2$ neutral extraction, clean up, isothermal packed column GC and FID; method will not resolve all compounds
Chlorinated Hydrocarbons	RCRA 8120-$MeCl_2$ neutral extraction, clean up, isothermal packed column GC/ECD
Organophosphorus pesticides	RCRA 8140-$MeCl_2$ neutral extraction, temperature programmed packed column GC/FPD
Chlorinated Herbicides	RCRA 8150-Ether acid extraction, clean up and derivatization with diazo methane, then programmed packed column GC/ECD

For selenium and arsenic, the solution resulting from the digestion of the sample is treated with stannous chloride to form intermediate reduced species, AsO_2^- and $SeO_2^=$. The solution is then treated with zinc metal, converting the reduced species to the volatile hydride. The hydride is then detected by the AAS method. For mercury, the solution resulting from the digestion of the sample is treated with stannous sulfate, which reduces the ionic mercury in the sample to the atomic species. The volatile atomic mercury is swept from the sample in a closed system to an absorption cell to a scrubber trap. The level of mercury in the vapor is obtained from the integrated AAS signal formed during its evolution from the sample.

External calibration curves are prepared by plotting the absorbance (AAS) or transmittance (ICAP) versus concentration for a series of standards which span the linear working range of the analytical instrument. On comparing the measured absorptions (or transmittance) of the sample analyzed under the same conditions as the standard, the concentration of material in the sample can be interpolated from a calibration curve. Table 10 lists the RCRA procedure used to characterize the hazardous metal content of wastes.

Some of the inorganic species listed in the ITD/RCRA list (see Appendix) are hazardous because of the anionic portion of the compound. These compounds, which contain either cyanide, phosphide, or sulfide, are analyzed by a single method for that anion. The general procedure for the determination of anions in solution employs ion chromatography as the preferred analytical technique. It should be noted that some of the sample preparation methods can

TABLE 10. RCRA METHODS FOR METAL ANALYSIS OF WASTES

Metal	RCRA Method Number			
	AAS	AAS-GF	ICAP	Other
Antimony	7040	7041	6010	
Arsenic	7061*	7060	6010	
Barium	7080	7081	6010	
Beryllium	7090	7091	6010	
Cadmium	7130	7131	6010	
Chromium	7190	7191	6010	
Copper	7210	7211	6010	
Lead	7420	7421	6010	
Mercury	--	--	--	7440**
Nickel	7520	7521	6010	
Osmium	7550	7521	6010	
Selenium	7741*	7740	--	
Silver	7760	7761	6010	
Thallium	7840	7841	6010	
Vanadium	7910	7911	6010	
Zinc	7950	7951	6010	

*Gaseous Hydride Method

**Cold Vapor

convert these compounds to volatile species, which could be removed from the waste inadvertently. Care must be exercised during the sample treatment effort to either intentionally trap these volatile species or use an alternative method (alkaline digestion/extraction) to ensure their retention in the sample.

Scrubbing the effluent from the acid treatment of waste containing cyanide with sodium hydroxide solution permits retention of the cyanide, which subsequently can be analyzed by standard colorimetric methods. Conversion of phosphide containing inorganic species to perform gaseous phosphine can be analyzed by its direct measurement using a flame photometric detector or by scrubbing in basic media and conversion to phosphate and analyzed using ion chromatographic methods. Similarly, the sulfide species in wastes can be converted to gaseous hydrogen sulfide and analysis via flame photometric methods or by scrubbing in zinc acetate. Excess iodine is added and the excess is back titrated using sodium thiosulfate.

Gaseous inorganic species are usually analyzed using specific procedures. These methods are often based on gas chromatography with either selective detectors such as alkali flame ionization detectors, a flame photometric detector, an electron capture detector, or a non-specific detector such as thermoconductivity. In some specific cases, gaseous inorganic species are analyzed using infrared spectrometric methods.

SECTION 5

QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

An essential part of any sampling and analysis program is the provision for procedures which maintain the quality of the data throughout the sampling and analysis effort. The level of quality assurance applied to a specific activity depends upon the project objectives and the end uses of the data generated. Usually, a flexible program is generated which also ensures that all data are of sufficient and appropriate quality to meet sampling and analysis project requirements. It is essential that these data are complete, representative, comparable, valid, of known precision and accuracy, and legally defensible. Quality assurance (QA), therefore, represents the total integrated program for assuring the reliability of monitoring and measurement information. The assurance of this reliability is, in turn, maintained through the use of discrete quality control (QC) functions which involve the routine application of procedures for obtaining prescribed sampling and analysis standards of performance.

The US EPA has established a requirement that all measurement activities are covered by a Quality Assurance Project Plan (QAPP). This section provides a brief description of the essential elements to this plan which satisfy the mandatory EPA requirements (Ref. 11). These 16 essential elements are listed in Table 11. The first three elements of the QAPP are self-explanatory. The project description is typically presented in some detail, whether the plan be primarily an analysis of waste provided by EPA contracted sampler organizations, or the activity be an application of a control technology such as

TABLE 11. ESSENTIAL ELEMENTS OF A QA PROJECT PLAN

1.	Title Page
2.	Table of Contents
3.	Project Description
4.	Project Organization and Responsibility
5.	QA Objectives
6.	Sampling Procedures
7.	Sample Custody
8.	Calibration Procedures and Frequency
9.	Analytical Procedures
10.	Data Reduction, Validation, and Reporting
11.	Internal Quality Control Checks
12.	Performance and System Audits
13.	Preventive Maintenance
14.	Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness
15.	Corrective Action
16.	Quality Assurance Reports to Management

incineration or landfilling. A brief summary of the project, a list of the waste to be treated, specific analyses to be performed, and target analyte detection limits are usually provided.

In the project organization and responsibility section, individuals who have responsibility for the following functions in specifying the QA/QC program are identified:

- Project Manager,
- The Quality Assurance Coordinator,
- The Analysis Coordinator,
- The Sampling Coordinator, and
- The Quality Control and Data Manager.

These individuals all have specific functions in conducting the measurement activities which need to be described in the QA Project Plan.

The quality assurance objectives of the measurement activity are summarized in terms of precision, accuracy, completeness, representativeness, and comparability for each measurement parameter. Quality assurance objectives for accuracy and precision will be based on prior knowledge of the measurement system employed and methods validation study using replicates, spikes, standards, calibration, recovery studies, etc., and the requirements of the specific effort.

For each major measurement parameter(s), including all pollutant measurement systems, the sampling procedures will be described. To be included are descriptions of techniques or guidelines, use of selected sampling sites, inclusion of specific sampling procedures, charts, flow diagrams or tables delineating sampling program operations, and a description of containers, procedures, reagents, etc., used for sample collection, preservation, transport and storage. Also included are special conditions for the preparation of sampling equipment and containers, sample preservation methods and holding

times, time consideration for shipping samples, sample custody or chain-of-custody procedures, and forms, notebooks and procedures to be used to record the sampling history, sampling conditions, the analysis to be performed.

Sample custody information is required, and when used for legal purposes, "chain-of-custody" procedures must be described. At a minimum, detailed documentation of procedures for field sampling operations and laboratory operations are required.

Calibration procedures and frequency information is needed for both the sampling and analysis efforts. Incorporated in the QAPP for each major measurement parameter, including all pollutant measurement systems, is information on the frequency plan for recalibration, as well as calibration standards and their sources.

For each major measurement parameter, including all pollutant measurement systems, standard operating analytical procedures need to be cited or written descriptions given. Many specific analytes have yet to be validated, and hence, QC data on analysis of surrogates, duplicates and spiked samples serve as indicators of the performance of the sample preparation and analytical methods.

Explicit information is required in the QAPP regarding data reduction, validation and reporting procedures. For each measurement parameter, including all pollutant measurement systems, information is required regarding

the planned data reduction scheme to be used to calculate the concentration or value of the measured parameter and reporting units. The principal criteria that will be used to validate the data integrity should be reported as well as methods used to identify and treat outlying data. Data flow or reporting scheme from collection of raw data through storage of validated concentrations is also required.

All specific internal quality control methods used to check the data need to be discussed in a QAPP. Examples of items to be included are: replicates, spiked samples, split samples, control charts, blanks, internal standards, zero and span gases, quality control samples, surrogate samples, calibration standards and devices, and reagent checks.

Each QAPP must describe the internal and external performance and system audits which will be used to monitor the capability and performance of the total measurement system. Normally, a systems audit is made by the Project Manager and Quality Assurance Officer prior to the implementation of any new experimental procedures. In support of performance audits, often the regulatory organization provides performance evaluation samples periodically to ensure that the data generated by the laboratory remains in control. On-site auditing regarding organization and personnel, facilities and equipment, analytical methodology, sample custody procedures, quality control, and data handling is accomplished for the CERCLA requirements on a quarterly basis.

The following types of preventive maintenance items should be considered and addressed in the QAPP:

- A schedule of important preventive maintenance tasks that must be carried out to minimize downtime of both the sampling and measurement systems, and
- A list of any critical spare parts that should be on hand to minimize downtime.

A series of specific routine procedures must be developed and documented to assess data precision, accuracy, and completeness. Mean values and estimate of precision are provided by normal statistical means using the relative standard deviation as the precision measurement. The accuracy is assessed by mean recovery of surrogate compound and/or, in the case of stable labeled compound (e.g., Method 1624/1625), by use of the stable labeled standard addition analyte. When it is determined that the causes of variance need to be assessed, it is accomplished typically using the sampling and analysis procedure shown in Figure 3. The analysis of a minimum of seven samples prepared as shown in Figure 3 permits estimation of the causes of variance from either sampling, preparation and measurement (Ref. 12), e.g.,

$$S^2_{Total} = S^2_{Sampling} + S^2_{Preparation} + S^2_{Measurement}$$

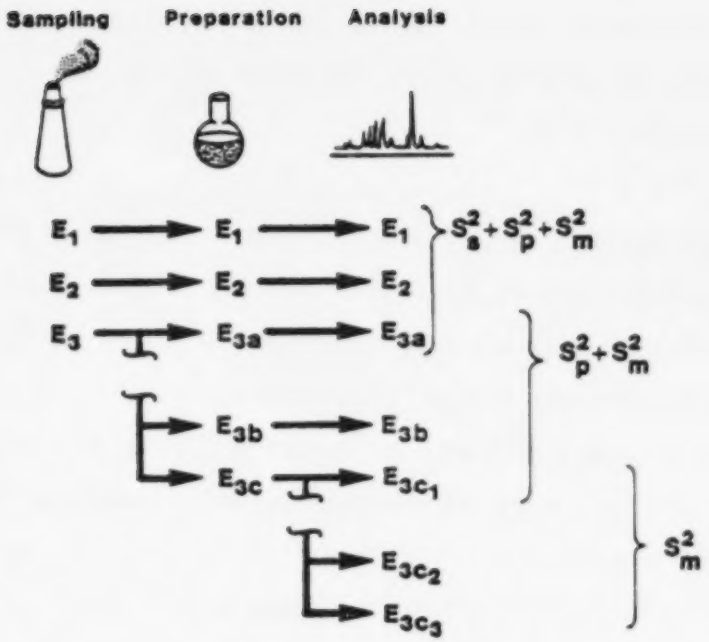

Figure 3. Diagram of a sampling and analysis procedure which uses replicate samples to provide information on sources of variance

Corrective action procedures must be described for each project, which includes the following elements:

- Predetermined limits for data acceptability beyond which corrective action is required,
- Procedures for corrective action, and
- Identification of the responsible individual for initiating the corrective action and the individual responsible for approving the corrective action, if necessary.

Corrective actions may also be initiated as a result of other QA activities, including performance audits, systems audits, laboratory/interfield comparison studies, and QA program audits conducted by the EPA Quality Assurance Management Staff.

Quality assurance reports are initiated during regular meetings among the Quality Assurance Officer, the Project Manager, and key staff responsible for sampling, analysis, QC, and data management to review the QC data summaries, documentation and other aspects of the project quality assurance performance. The Quality Assurance Officer's assessment of the adequacy of project quality control/quality assurance performance is then summarized in a memorandum distributed to upper corporate/institutional management, as well as to the Project Manager and the cognizant line management.

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APPENDIX

This appendix is a comprehensive compilation of specific compounds that have been identified as hazardous in EPA regulations, or in proposed additions to regulations that may exist in waste materials (Ref. 5). This list includes all compounds in the RCRA Appendix VIII list, the proposed addition to that list (Michigan Petition), the CERCLA Hazardous Substance List, the Priority Pollutant List, Appendix C Pollutants, and High Priority Paragraph 4(c) Pollutants, together with compounds not specifically identified in the lists cited above, but are covered by compound class citations in the Appendix VIII list. The empirical formula and CAS registry number are presented for each compound, together with an indication of known analysis methods or probable applicable methods, the promulgated EPA method, and applicable RCRA method, when known.

Analysis and other information is coded in the table as shown below:

CVAA = Cold vapor atomic absorption spectroscopy

DIOXIN = Analysis for dibenzo-p-dioxins and dibenzofurans

GC-PROB = Probably determined by GC with analyte-specific detector

GC-EC = Gas chromatography with electron capture detector

GCMS = Gas chromatography/mass spectrometry

GC-NPD = Gas chromatography with nitrogen-phosphorous detector

HPLC = High performance liquid chromatography

HPLC-UV = HPLC with ultra-violet detector

ICP = Inductively coupled argon plasma spectrometry

MAS = Determined using Master Analytical Scheme

MS-PROB = Probably determined using mass spectrometry

NO GCMS = Cannot be determined using GCMS

TEM = Transmission electron microscopic analysis

WET = Classical wet method

SRC - Denotes this analyte will be identified by computer search of an analyte-specific library in GCMS data

H - Analyte hydrolyzes in water

Table A.1 ITD/RCRA COMPOUND DATA

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Acenaphthene	$C_{12}H_{10}$	83-32-9	GCMS	1625	8270	
Acenaphthene, 5-nitro	$C_{12}H_9NO_2$	602-87-9	MS-PROB	SRCH		
Acenaphthylene	$C_{12}H_8$	208-96-9	GCMS	1625	8270	
Acetamide N-(4-5-nitro-22-furyl)-thiazolyl)	$C_8H_7N_3O_2S$	531-82-8	HPLC	--		
Acetic acid, (4-[bis(2-chloroethyl) amino]phenyl)-cholesteryl ester	$C_{39}H_{59}Cl_2NO_2$	3546-10-9	HPLC	--		
Acetonitrile	C_2H_3N	75-07-8	GCMS	SRCH		
3-(alpha-Acetonylbenzyl)-4-hydroxycoumarin and salts	$C_{19}H_{16}O_4$•Na	129-06-6	--	--		
Acetophenone	C_8H_8O	98-86-2	MS-PROB	SRCH		
Acetyl chloride	C_2H_3ClO	95-36-5	--	--		H
1-Acetyl-2-thiourea	$C_3H_6N_2OS$	591-08-2	MS-PROB	SRCH		
2-Acetylaminofluorene	$C_{15}H_{13}NO$	17364-30-6	MS-PROB	SRCH		
Acrolein	C_3H_4O	107-02-8	GCMS	1624	8240	
Acrylamide	C_3H_3N	79-06-1	MAS	SRCH		
Acrylonitrile	C_3H_3N	107-13-1	GCMS	1624	8240	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Actinomycin D	$C_{62}H_{86}N_{12}O_{16}$	50-76-0	HPLC	--		
Aflatoxins	$C_{17}H_{12-14}O_{6-7}$	1402-62-2	NO-GCMS	--		
Aldrin	$C_{12}H_8Cl_6$	309-00-2	GCEC	608	8080	
Allyl alcchol	C_3H_6O	107-18-6	MAS	SRCH		
Aluminum phosphide	AlP	20859-73-8	ICP	--	1610	
6-Amino-11,1a,2,8a,8b-hexahydro-8-(hydroxym ethyl)-8a-methoxy-5-methyl-carbamate azirino[2',3':3,4]pyrrolo [1,2a]indole-4,7-dione, (ester)	$C_{15}H_{18}N_4O_5$	50-07-7	HPLC-UV	--		
3-Amino-9-ethyl carbazole	$C_{12}H_{14}N$	132-32-1	MS-PROB	SRCH		
4-Aminobiphenyl	$C_{12}H_{11}N$	92-67-1	MS-PROB	SRCH		
5-(aminomethyl)-3-isoxazolol	$C_4H_6N_2O$	2763-96-4	HPLC	--		
Amitrole	$C_2H_4N_4$	61-82-5	--	--		
Ammonium salt (of saccharin)	$C_7H_5NO_3S{\cdot}H_3N$	6381-61-9	--	--		H
Ammonium, (4-(p-(dimethylamino)-alpha-phenyl benzylidine)-2,5- cylcohexadien-1-ylidene)-dimethyl-, chloride	$C_{23}H_{25}N_2{\cdot}Cl$	569-64-2	--	--		
Aniline	C_6H_7N	62-53-3	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Aniline, 2,4,5-trimethyl-	$C_9H_{13}N$	1377-17-7	MS-PROB	SRCH		
Aniline, 4,4'-methylenebis (2-methyl)-	$C_{15}H_{18}N_2$	838-88-0	MS-PROB	SRCH		
Aniline, 4,4'-methylenebis (N,N-dimethyl)-	$C_{17}H_{14}N_2$	101-61-1	MS-PROB	SRCH		
Aniline, 4,4'-thiodi-	$C_{12}H_{12}N_2S$	139-65-1	HPLC	--		
Aniline, p-(phenylazo)-	$C_6H_{11}N_2$	60-09-3	HPLC	--		
o-Anisidine	C_9H_9NO	90-04-0	MS-PROB	SRCH		
o-Anisidine hydrochloride	$C_9H_{10}NClO$	134-29-2	--	--		H
o-Anisidine, 5-methyl	$C_{10}H_{11}NO$	120-71-8	--	--		H
o-Anisidine, 5-nitro	$C_{10}H_8N_2O_3$	99-59-2	MS-PROB	SRCH		
Anthracene	$C_{14}H_{10}$	120-12-7	GCMS	1625	8270	
Anthraquinone, 1-amino-2-methyl	$C_{15}H_{10}$	120-12-7	GCMS	1625	8270	
Anthraquinone, 2-amino	$C_{14}H_9NO_2$	117-79-3	MS-PROB	SRCH		
Anthraquinone, 2-methyl-1-nitro	$C_{15}H_9NO_4$	129-15-7	--	--		
Antimony	Sb	7440-36-0	FURN-AA	--	7041	
Antimony(III)chloride	$SbCl_3$	10025-91-9	FURN-AA	7041		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Antimony(V)chloride	$SbCl_5$	7647-18-9	ICP	--	6010	
Aramite	$C_{15}H_{23}ClO_4S$	140-57-8	MS-PROB	SRCH		
Arsenic	As	7440-38-2	FURN-AA	--	7060	
Arsenic acid	H_3AsO_4	7778-39-4	FURN-AA	--	7060	
Arsenic pentoxide	As_2O_5	1303-28-2	FURN-AA	--	7060	
Arsenic trioxide	As_2O_3	1327-53-3	FURN-AA	--	7060	
Asbestos	--	13322-21-4	TEM	--		
Auramine	$C_{17}H_{21}N_3$	2465-27-2	GCMS	SRCH		
Azaserine	$C_5H_7N_3O_4$	115-02-6	HPLC	--		
Barbituric acid, 5-ethyl-5-phenyl	$C_{12}H_{12}N_2O_3$	50-06-6	MS-PROB	SRCH		
Barium	Ba	7440-39-3	ICP	--	6010	
Barium cyanide	C_2BaN_2	543-62-1	WET	--		
Benz(c)acridine	$C_{17}H_{11}N$	255-51-4	MS-PROB	SRCH		
Benzanthrone	$C_{16}H_{10}O$	82-05-3	GCMS	SRCH		
Benzenamine hydrochloride	C_6H_8NCl	142-04-1	--	--		H
Benzene	C_6H_6	71-43-2	GCMS	1624	8240	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Benzene, 1,2-(methylenedioxy)-4-(2-(octylsulfinyl)propyl)-	$C_{18}H_{28}O_3S$	120-62-7	--	-		H
Benzene, dichloromethyl-	$C_7H_6Cl_2$	98-87-3	MS-PROB	SRCH		
Benzenearsonic acid	$A_6H_7AsO_3$	998-05-5	HPLC	--		
Benzenethiol	C_6H_6S	92-87-5	GCMS	1625	8270	
Benzidine sulfate	$C_{12}H_{12}N_2 \cdot H_2O_4S$	531-886-2	--	--		
2-Benzimidazolecarbamic acid, 1-(butylcarbamoyl)-, methyl ester	$C_{14}H_{18}N_2O_3$	17804-35-2	HPLC-UV	--		
Benzo(a)anthracene	$C_{18}H_{12}$	56-55-3	GCMS	1625	8270	
Benzo(a)pyrene	$C_{20}H_{12}$	50-32-8	GCMS	1625	8270	
Benzo(b)fluoranthene	$C_{20}H_{12}$	205-99-2	GCMS	1625	8270	
Benzo(ghi)perylene	$C_{24}H_{14}$	191-24-2	GCMS	1625	8270	
Benzo(j)fluoranthene	$C_{20}H_{12}$	205-82-3	GCMS	SRCH		
Benzo(k)fluoranthene	$C_{20}H_{12}$	207-08-0	GCMS	1625	8270	
2,3-Benzofluorene	$C_{17}H_{14}$	243-17-4	GCMS	SRCH		
Benzoic acid	$C_7H_6O_2$	65-85-0	GCMS	SRCH		
Benzonitrile, 3,5-dibromo-4-hydroxy-	$C_7H_3NBr_2O$	1689-84-5	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
(1)-Benzopyrano(3,4-b)furo(2,3-h)(1) benzopyran-6(6aH)-one, 1,2,12,12a-tetrahydro-2-alpha-isopropenyl-8,9-dimethoxy	$C_{23}H_{22}O_6$	83-79-4	HPLC-UV	--		
p-Benzoquinone	$C_6H_4O_2$	106-51-4	P-POLL	SRCH		
Benzotrichloride	$C_7H_5Cl_3$	98-07-7	MS-PROB	SRCH		H
Benzyl alcohol	C_7H_8O	100-51-6	SRCH	--		
Benzyl chloride	C_7H_7Cl	100-44-7	MS-PROB	SRCH		H
Beryllium	Be	7440-41-7	ICP	--	6010	
gamma-BHC	$C_6H_6Cl_6$	7440-41-7	GCEC	608	8080	
alpha-BHC	$C_6H_6Cl_6$	319-84-6	GCEC	608	8080	
beta-BHC	$C_6H_6Cl_6$	319-85-7	GCEC	608	6080	
delta-BHC	$C_6H_6Cl_6$	319-86-8	GCEC	608	6080	
Biphenyl	$C_{12}H_{10}$	92-52-4	GCMS	1625	8270	
Biphenyl, 4-nitro	$C_{12}H_9NO_2$	92-93-3	MS-PROB	SRCH		
4,4'-Bipyridinium, 1,1'-dimethyl-, dichloride	$C_{12}H_{14}N_2Cl_2$	1910-42-5	--	--		
4-Bromo-1,2-dichlorobenzene	$C_6H_3Cl_2Br$	18282-59-2	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
1-Bromo-2-chlorobenzene	C_6H_4ClBr	694-80-4	GCMS	SRCH		
1-Bromo-3-chlorobenzene	C_6H_4ClBr	1008-37-2	GCMS	SRCH		
4-Bromo-3-chlorophenol	C_6H_4ClBrO	13631-21-5	MS-PROB	SRCH		
2-Bromo-4-chlorophenol	C_6H_4ClBrO	695-96-5	MS-PROB	SRCH		
2-Bromo-4-tert-butylphenol	$C_{10}H_{13}BrO$	2198-66-5	MS-PROB	SRCH		
Bromoacetone	C_3H_5BrO	598-31-2	MS-PROB	SRCH		
Bromodichloromethane	$CHCl_2Br$	75-27-4	GCMS	1624	8240	
Bromomethane	CH_3Br	74-83-9	GCMS	1624	8240	
4-Bromophenyl phenyl ether	$C_{12}H_9BrO$	101-55-3	GCMS	1625	8270	
Brucine	$C_{23}H_{26}N_2O_4$	357-57-3	HPLC	--		
1,3-Butadiene, 2-chloro	C_4H_5Cl	126-99-8	MS-PROB	SRCH		
1-Butanol, 4-(butylnitrosoamino)-	$C_8H_{18}N_2O_2$	3817-11-6	--	--		
2-Butanone	C_4H_8O	78-93-3	GCMS	1624	8240	
2-Butanone peroxide	$C_8H_{16}O_4$	1338-23-4	--	--		H
Butyl benzyl phthalate	$C_{19}H_{20}O_4$	85-68-7	GCMS	1625	8270	
2-sec-butyl-4,6-dinitrophenol	$C_{10}H_{12}N_2O_5$	88-85-7	GCEC	615	8090	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Cadmium	Cd	7440-43-9	ICP	--	6010	
Calcium chromate	$Ca{\cdot}CrH_2O_4$	13765-19-0	ICP	--	6010	H
Calcium cyanide	C_2CaN_2	592-01-8	WET	--		
Calcium salt (of saccharin)	$C_7H_5NO_3S{\cdot}1/2Ca$	6485-34-3	--	--		H
Carbamic acid, diethyldithio, 2-chloroallyl ester	$C_8H_{14}ClNS_2$	95-06-7	GCMS	SRCH		
Carbamic acid, m-chloro,4-chloro-2-butynyl ester	$C_{11}H_9NO_2Cl_2$	101-27-9	HPLC-UV	632		
Carbamic acid, methyl-, 1-naphthyl ester	$C_{12}H_{11}NO_2$	63-25-2	HPLC-UV	632		
Carbamic acid, methyl-, 2,3-(dimethylmethylenedioxy)phenyl ester	formula	22781-23-3	--	--		
Carbamic acid, methyl-, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl ester	$C_{12}H_{13}NO_3$	1563-66-2	HPLC-UV	632		
Carbamic acid, methyl-, 4-dimethyl-amino-3,5-xylyl ester	$C_{12}H_{18}N_2O_2$	315-18-4	HPLC-UV	632		
Carbazole	$C_{12}H_9N$	86-74-8	GCMS	1625	8270	
Carbon disulfide	CS_2	75-15-0	GCMS	SRCH		
Carbon oxyfluoride	CF_2O	3353-50-4	--	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Chloral	C_2HCl_3O	755-87-6	--	--		
Chlorambucil	$C_{14}H_{19}Cl_2NO_2$	385-03-3	HPLC	--		
Chlordane	$C_{10}H_6Cl_6$	57-74-9	GCEC	608	8080	
Chlorinated benzenes, NOS	$C_6H_{6-x}Cl_x$	1-06-4	GCMS	--		
Chlorinated ethane, NOS	$C_2H_{6-x}Cl_x$	1-06-5	GCMS	--		
Chlorinated fluorocarbons, NOS	--	1-06-7	GCMS	--		
Chlorinated napthalene, NOS	$C_{10}H_{8-x}Cl_x$	1-06-8	GCMS	--		
Chlorinated phenol, NOS	$C_6H_{6-x}Cl_xO$	1-06-8	GCMS	--		
Chlorine	Cl_2	7782-50-5	WET	--		
1-Chloro-2,3-epoxypropane	C_3H_5ClO	106-89-8	GCMS	SRCH		H
4-Chloro-2-nitroaniline	$C_6H_5N_2ClO_2$	89-63-4	GCMS	SRCH		
1-Chloro-3,5-dibromobenzene	$C_6H_3ClBr_2$	14862-52-3	MS-PROB	SRCH		
4-Chloro-3-methylphenol	C_7H_7ClO	59-50-7	GCMS	1625	8270	
1-Chloro-3-nitrobenzene	$C_6H_4NClO_2$	121-73-3	GCMS	SRCH		
2-Chloro-4-t-butylphenol	$C_{10}H_{12}ClO$	94-28-2	MS-PROB	SRCH		
6-Chloro-o-cresol	C_7H_7ClO	87-64-9	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Chloroacetaldehyde	C_2H_3ClO	107-20-0	--	--		
Chloroacetonitrile	C_2H_2NCl	107-14-2	GCMS	SRCH		
Chloroalkylethers, NOS	--	--	GCMS	--		
p-Chloroaniline	C_6H_6NCl	106-47-8	GCMS	SRCH		
Chlorobenzene	C_6H_5Cl	108-90-7	GCMS	1624	8240	
Chlorobenzilate	$C_{16}H_{14}Cl_2O_3$	510-15-6	GCEC	6081		
Chloroethane	C_2H_5Cl	75-00-3	GCMS	1624	8240	
bis(2-Chloroethoxy)methane	$C_5H_{10}Cl_2O_2$	111-91-1	GCMS	1625	8270	
bis(2-Chloroethyl) ether	$C_4H_8Cl_2O$	111-44-4	GCMS	1625	8270	
N,N-Bis(2-chloroethyl)-2-naphthylamine	$C_{14}H_{15}Cl_2N$	494-02-1	MS-PROB	SRCH		
2-Chloroethylvinyl ether	C_4H_7ClO	110-75-8	GCMS	1624	8240	
Chloroform	$CHCl_3$	67-66-3	GCMS	1624	8240	
Chloroisocyanotobenzene	C_7H_4NClO	51124-03-3	MS-PROB	SRCH		
bis(2-Chloroisopropyl) ether	$C_6H_{12}Cl_2O$	108-60-1	GCMS	1625	8270	
Chloromethane	CH_3Cl	74-87-3	GCMS	1624	8240	
Chloromethyl methyl ether	C_2H_5ClO	107-30-2	--	--		H

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Bis(chloromethyl)ether	$C_2H_4Cl_2O$	5542-88-1	GCMS	SRCH		H
1-(Chloromethyl)naphthalene	$C_{10}H_9Cl$	86-52-2	GCMS	SRCH		
2-Chloronaphthalene	$C_{10}H_7Cl$	91-58-7	GCMS	1625	8270	
2-Chlorophenol	C_6H_5ClO	95-57-8	GCMS	1625	8270	
p-Chlorophenol	C_6H_5ClO	106-48-9	GCMS	SRCH		
m-Chlorophenol	C_6H_5ClO	108-43-0	GCMS	SRCH		
1-(o-Chlorophenyl)thiourea	$C_7H_7N_2ClS$	5344-82-1	GCMS	SRCH		
4-Chlorophenylphenyl ether	$C_{12}H_9ClO$	7005-72-3	GCMS	1625	8270	
3-Chloropropene	C_3H_5Cl	107-05-1	MS-PROB	SRCH		
3-Chloropropionitrile	C_3H_4NCl	542-76-7	MS-PROB	SRCH		
Cholesterol	$C_{27}H_{46}O$	57-88-5	GCMS	SRCH		
Chromium	Cr	7440-47-3	ICP	--	6010	
Chrysene	$C_{18}H_{12}$	2158-01-9	GCMS	1625	8270	
Citrus red No. 2	$C_{18}H_{16}N_2O_3$	6358-53-8	HPLC	--		
Coal tars	--	8007-45-2	GCMS	--		
Cobalt (II) chloride	$CoCl_2$	7646-79-9	ICP	--	6010	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Cobalt, when in the form of paricles 100 microns or less	Co	7440-48-4	ICP	--	6010	
Copper	Cu	7440-58-8	ICP	--	6010	
Copper cyanide	CNCu	544-92-3	ICP	--	6010	
Copper cyanide	C_2N_2Cu	14763-77-0	ICP	--	6010	
Coumarin, 3-chloro-7-hydroxy-4-methyl-, O-ester with o,o-diethyl pyrophosphorothioate	$C_9H_6O_2$	56-72-4	GC-NPD	622		H
Creosote	--	8021-39-4	GCMS	SRCH		
o-Cresol	C_7H_8O	95-48-7	GCMS	SRCH		
p-Cresol	C_7H_8O	106-44-5	GCMS	SRCH		
m-Cresol	C_7H_8O	108-39-4	GCMS	SRCH		
Cresols	C_7H_8O	1319-77-3	GCMS	SRCH		
Crotonaldehyde	C_4H_6O	4170-30-3	MS-PROB	SRCH		
Crotonic acid, 2-(1-methylheptyl)-4,6-dinitrophenyl ester	$C_{18}H_{24}N_2O_6$	39300-45-3	GC-PROB	SRCH		
Crotonic acid, 3-hydroxy, alpha-methylbenzyl ester, dimethyl phosphate (E)-	$C_{14}H_{19}O_6P$	7700-17-6	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Crotonic acid, 3-hydroxy, methyl ester, dimethyl phosphate (E)-	$C_7H_{13}O_6P$	7786-34-7	GC-NPD	SRCH		
Cyanides (soluble salts and complexes) NOS	--	52-17-5	WET	--		
Cyanogen	C_2N_2	460-19-5	--	--		H
Cyanogen bromide	CNBr	506-68-3	--	--		H
Cyanogen chloride	CNCl	506-77-4	--	--		H
Cycasin	$C_8H_{16}N_2O_7$	14901-08-7	HPLC	--		
4-Cyclohexene-1,2-dicarboximide N-((11,1,2,2-tetrachloroethyl)thio)-	$C_{10}H_5NO_2Cl_4S$	2425-06-1	GC-PROB	SRCH		
4-Cyclohexene-1,2-dicarboximide N-(trichloromethyl)thio-	$C_9H_4NO_2Cl_3S$	133-06-2	GCEC	617		
2-Cyclohexyl-4,6-dinitrophenol	$C_{12}H_{14}N_2O_5$	1131-89-5	GC-PROB	SRCH		
Cyclophosphamide	$C_7H_{15}N_2Cl_2OP$	50-18-0	MS-PROB	SRCH		
p-Cymene	$C_{10}H_{14}$	99-87-6	GCMS	1625	8270	
Daunomycin	$C_{27}H_{29}NO_{10}$	20830-81-3	HPLC	--		
4,4'-DDD	$C_{14}H_{10}Cl_4$	72-54-8	GCEC	608	8080	
4,4'DDE	$C_{14}H_8Cl_4$	722-55-9	GCEC	608	8080	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
4,4'DDT	$C_{14}H_9Cl_5$	50-29-3	GCEC	608	8080	
Decachlorobiphenyl	$C_{12}Cl_{10}$	2051-24-3	MS-PROB	SRCH		
n-Decane	$C_{10}H_{22}$	124-18-5	GCMS	1625	8270	
Di-n-butyl phthalate	$C_{16}H_{22}O_4$	117-84-0	GCMS	1625	8270	
Di-n-propylnitrosamine	$C_6H_{14}N_2O$	621-64-7	GCMS	1625	8270	
2,6-di-tert-Butyl-p-benzoquinone	$C_{14}H_{13}O$	719-22-2	GCMS	SRCH		
Diallate	$C_{10}H_{17}ClNOS$	2303-16-4	--	--		
2,6-Diaminotoluene	$C_4H_{10}N_2$	823-40-5	GCMS	SRCH		
Dibenx(a,h)acridine	$C_{21}H_{13}N$	226-36-8	MS-PROB	SRCH		
Dibenz(a,j)acridine	$C_{21}H_{13}N$	224-42-0	MS-PROB	SRCH		
Dibenzo(a,e)pyrene	$C_{24}H_{12}$	192-65-4	GCMS	SRCH		
Dibenzo(a,h)anthracene	$C_{22}H_{14}$	53-70-3	GCMS	1625	8270	
Dibenzo(a,h)pyrene	$C_{24}H_{14}$	189-64-0	GCMS	SRCH		
7H-Dibenzo(c,g)carbazole	$C_{20}H_{13}N$	194-59-2	MAS	--		
Dibenzofuran	$C_{12}H_8O$	132-64-9	GCMS	1625	8270	
Dibenzothiophene	$C_{12}H_8S$	132-65-0	GCMS	1625	8270	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
1,2-Dibromo-3-chloropropane	$C_3H_5Cl_2Br$	96-12-8	GCMS	SRCH		
1,3-Dibromobenzene	$C_6H_4Br_2$	108-36-1	GCMS	SRCH		
Dibromochloromethane	$CHCl_2Br$	124-48-1	GCMS	1624	8240	
1,2-Dibromoethane	$C_2H_4Br_2$	106-93-4	GCMS	SRCH		
Dibromomethane	CH_2Br_2	74-95-3	GCMS	SRCH		
trans-1,2-Dichloroethene	$C_2H_2Cl_2$	156-60-5	GCMS	1624	8240	
2,3-Dichloro-1-propanol	$C_3H_6Cl_2O$	616-23-9	MS-PROB	SRCH		
trans 1,4-Dichloro-2-butene	$C_4H_6Cl_2$	110-57-6	GCMS	SRCH		
cis-1,4-Dichloro-2-butene	$C_4H_6Cl_2$	764-41-0	GCMS	SRCH		
1,3-Dichloro-2-propanol	$C_3H_6Cl_2O$	96-23-1	MS-PROB	SRCH		
3,5-Dichloro-4-aminophenol	$C_6H_5NCl_2O$	26271-75-0	MS-PROB	SRCH		H
2,5-Dichloro-4-methoxyphenol	$C_7H_6Cl_2O_2$	18113-41-9	MS-PROB	SRCH		
2,6-Dichloro-4-nitroaniline	$C_6H_6N_2Cl_2O_2$	99-30-9	GCEC	617	8150	
1,3-Dichloro-5-bromobenzene	$C_6H_3Cl_2Br$	19752-55-7	MS-PROB	SRCH		
2,3-Dichloroaniline	$C_6H_5NCl_2$	608-27-5	GCMS	SRCH		
1,2-Dichlorobenzene	$C_6H_4Cl_2$	95-50-1	GCMS	1625	8270	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
1,4-Dichlorobenzene	$C_6H_4Cl_2$	106-46-7	GCMS	1625	8270	
1,3-Dichlorobenzene	$C_6H_4Cl_2$	541-73-1	GCMS	1625	8270	
Dichlorobenzene, NOS	$C_6H_4Cl_2$	25321-22-6	GCMS	--		
3,3'-Dichlorobenzidine	$C_{12}H_{10}N_2Cl_2$	91-94-1	GCMS	1625	8270	
Dichlorodifluoromethane	CCl_2F_2	75-71-8	GCMS	SRCH		
1,1-Dichloroethane	$C_2H_2Cl_2$	75-34-3	GCMS	1624	8240	
1,2-Dichloroethane	$C_2H_4Cl_2$	107-06-2	GCMS	1624	8240	
1,1-Dichloroethene	$C_2H_2Cl_2$	75-35-4	GCMS	1624	8240	
cis-1,2-Dichloroethylene	$C_2H_2Cl_2$	156-59-2	GCMS	SRCH		
Dichloroethylene, NOS	$C_2H_2Cl_2$	25323-30-2	GCMS	--		
2,3-Dichloronaphthalene	$C_{10}H_6Cl_2$	2050-75-1	GCMS	SRCH		
2,3-Dichloronitrobenzene	$C_6H_3NCl_2O_2$	3209-22-1	GCMS	SRCH		
2,6-Dichlorophenol	$C_6H_4Cl_2O$	87-65-0	GCMS	SRCH		
2,4-Dichlorophenol	$C_6H_4Cl_2O$	120-83-2	GCMS	1625	8270	
2,5-Dichlorophenol	$C_6H_4Cl_2O$	583-78-8	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
2,4-Dichlorophenoxyacetic acid, salts and esters	$C_8H_6Cl_2O_3$	94-75-7	GCEC	615	8150	H
Dichlorophenylarsine	$C_6H_5AsCl_2$	696-28-6	--	--		H
1,2-Dichloropropane	$C_3H_6Cl_2$	78-87-5	GCMS	1624	8240	
1,3-Dichloropropane	$C_3H_6Cl_2$	26638-19-7	GCMS	SRCH		
Dichloropropane, NOS	$C_3H_6Cl_2$	--	GCMS	--		
Dichloropropanol, NOS	$C_3H_6Cl_2O$	--	GCMS	--		
1,3-Dichloropropene	$C_3H_4Cl_2$	542-75-6	GCMS	SRCH		
cis-1,3-Dichloropropene	$C_3H_4Cl_2$	10061-01-5	GCMS	SRCH		
trans-1,3-Dichloropropene	$C_3H_4Cl_2$	10061-02-6	GCMS	SRCH		
Dichloropropene, NOS	$C_3H_4Cl_2$	26952-23-8	GCMS	SRCH		
Dieldrin	$C_{12}H_8Cl_6O$	60-57-1	GCEC	608	8080	
1,2:3,4-Diepoxybutane	$C_4H_6O_2$	1464-53-5	GCMS	SRCH		
Diethyl ether	C_2H_6O	60-29-7	GCMS	1624	8240	
Diethyl phthalate	$C_{12}H_{14}O_4$	84-66-2	GCMS	1625	8270	
O,O-Diethyl S-methyl ester of phosphorodithioic acid	$C_5H_{13}O_2PS_2$	3288-58-2	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
O-O-Diethyl-O-(2-pyrazinyl) phosphorothioate	$C_8H_{11}N_2O_3PS$	297-97-2	GC-PROB	SRCH		
Diethylarsine	$C_4H_{11}As$	692-42-2	--	--		H
N,N'-Diethylhydrazine	$C_4H_{12}N_2$	1615-80-1	--	--		H
O,O-Diethylphosphoric acid, O-p-nitrophenyl ester	$C_{10}H_{14}NO_6P$	311-45-5	MS-PROB	SRCH		
Diethylstilbesterol	$C_{18}H_{20}O_2$	56-53-1	HPLC	--		
1,3-Difluorobenzene	$C_6H_4F_2$	372-18-9	MS-PROB	SRCH		
Dihydrosafrole	$C_{10}H_{12}O_2$	94-58-6	MS-PROB	SRCH		
3,4-Dihydroxy-alpha-(methylamino)-methyl benzyl alcohol (l)	$C_9H_{13}NO_3$	51-43-4	HPLC	--		
3,4-Dihydroxy-alpha-(methylamine)-methyl benzyl alcohol (d)	$C_9H_{13}NO_3$	150-05-0	HPLC	--		
3,4-Dihydroxy-alpha-(methylamino)-methyl benzyl alcohol (dl)	$C_9H_{13}NO_3$	329-65-7	HPLC	--		
Diisopropylfluorophosphate	$C_6H_{14}FO_3P$	55-91-4	--	--		
Dimethoate	$C_5H_{12}NO_3PS_2$	60-51-5	GC-PROB	SRCH		
3,3'-Dimethoxybenzidine	$C_{14}H_{16}N_2O_2$	119-90-4	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Dimethyl phthalate	$C_{10}H_{10}O_4$	131-11-3	GCMS	1625	8270	
Dimethyl sulfate	$C_2H_6O_4S$	77-78-1	--	--		H
Dimethyl sulfone	$C_2H_6SO_2$	67-71-0	GCMS	SRCH		
Dimethyl sulfoxide	C_2H_6SO	67-68-5	GCMS	SRCH		
3,3-Dimethyl-1-(methylthio)-2-butanone-O-[(methylamino) carbonyl] oxime	$C_9H_{20}N_2O_2S$	31916-18-4	--	--		
p-Dimethylaminoazobenzene	$C_{14}H_{15}N_3$	60-11-7	GCMS	SRCH		
7,12-Dimethylbenz(a)anthracene	$C_{20}H_{16}$	57-97-6	GCMS	SRCH		
3,3'-Dimethylbenzidine	$C_{14}H_{16}N_2$	119-93-7	MS-PROB	SRCH		
Dimethylcarbamoyl chloride	C_3H_6NClO	79-44-7	--	--		H
N,N-Dimethylformamide	C_3H_7NO	68-12-2	GCMS	SRCH		
1,1-Dimethylhydrazine	$C_2H_8N_2$	57-14-7	GCMS	SRCH		
1,2-Dimethylhydrazine	$C_2H_8N_2$	540-73-8	GCMS	SRCH		
3,6-Dimethylphenanthrene	$C_{16}H_{14}$	1576-67-6	GCMS	SRCH		
2,7-Dimethylphenanthrene	$C_{16}H_{14}$	1576-69-8	GCMS	SRCH		
alpha,alpha-Dimethylphenethylamine	$C_{10}H_{15}N$	122-09-8	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
2,4-Dimethylphenol	$C_8H_{10}O$	105-67-9	GCMS	1625	8270	
4,6-Dinitro-o-cresol	$C_7H_6N_2O_5$	534-52-1	GCMS	1625	8270	
1,3-Dinitrobenzene	$C_6H_4N_2O_4$	100-25-4	GCMS	SRCH		
Dinitrobenzene, NOS	$C_6H_4N_2O_4$	1-16-4	GCMS	--		
2,4-Dinitrophenol	$C_6H_4N_2O_5$	51-28-5	GCMS	1625	8270	
2,4-Dinitrotoluene	$C_7H_6N_2O_4$	121-14-2	GCMS	1625	8270	
2,6-Dinitrotoluene	$C_7H_6N_2O_4$	606-20-2	GCMS	1625	8270	
1,4-Dioxane	$C_4H_8O_2$	123-91-1	GCMS	1624	8240	
Diphenyl ether	$C_{12}H_{10}O$	101-84-8	GCMS	1625	8270	
Diphenylamine	$C_{12}H_{11}N$	122-39-4	GCMS	1625	8270	
Diphenylamine, 4-nitroso-	$C_{12}H_{10}N_2O$	156-10-5	GCMS	SRCH		
Diphenyldisulfide	$C_{12}H_{10}S_2$	882-33-7	GCMS	SRCH		
1,2-Diphenylhydrazine	$C_{12}H_{12}N_2$	122-66-7	GCMS	1625	8270	
Disulfoton	$C_8H_{19}O_2PS_3$	298-04-4	GCN-PD	622	8140	
2,4-Dithiobiuret	$C_2H_5N_3S_2$	541-53-7	HPLC	--		
n-Docosane	$C_{22}H_{46}$	629-97-0	GCMS	1625	8270	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
n-Dodecane	$C_{12}H_{26}$	112-40-3	GCMS	1625	8270	
n-Eicosane	$C_{20}H_{42}$	112-95-8	GCMS	1625	8270	
Endosulfan	$C_9H_6Cl_6O_3S$	115-29-7	GCEC	608		
Endosulfan sulfate	$C_9H_6Cl_6O_4S$	1031-07-8	GCEC	608	8080	
Endosulfan-I	$C_6H_6Cl_6O_3S$	959-98-8	GCEC	608	8080	
Endosulfan-II	$C_6H_6Cl_6O_3S$	33213-65-9	GCEC	608	8080	
Endrin	$C_{12}H_8Cl_6O$	72-20-8	GCEC	608	8080	
Endrin alcohol	$C_{12}H_8Cl_6O$	33058-12-7	--	--		
Endrin aldehyde	$C_{12}H_8Cl_6O$	7421-93-4	GCEC	608	8080	
Endrin and metabolites	--	--	GCEC	608	8080	
Endrin ketone	$C_{12}H_8Cl_6O$	53494-70-5	--	--		
Ethanol, 2-chloro-	C_2H_5ClO	107-07-3	MS-PROB	SRCH		
Ether, 2,4-dichlorophenyl p-nitrophenyl-	$C_{12}H_7NCl_2O_3$	1836-75-5	--	--		
Ethyl carbamate	$C_3H_7NO_2$	51-79-6	MS-PROB	SRCH		
Ethyl cyanide	C_3H_5N	107-12-0	MS-PROB	SRCH		
Ethyl methacrylate	$C_6H_{10}O_2$	97-63-2	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Ethyl methanesulfonate	$C_3H_8O_3S$	62-50-0	--	--		H
Ethylbenzene	C_8H_{10}	100-41-4	GCMS	1624	8240	
Ethylene oxide (oxirane)	C_2H_4O	75-21-8	GCMS	SRCH		
Ethylenebisdithiocarbamic acid, salts and esters	$C_4H_8N_2S_4$	111-54-6	HPLC	--		
Ethylenebisdithiocarbamic acid, -manganese salt	$C_4H_6N_2S_4Mn$	12427-38-2	GC-PROB	SRCH		
Ethylenebisdithicarbamic acid, -sodium salt	$C_4H_6N_2S_4Na_2$	142-59-6	CS2	630		
Ethylenebisdithiocarbamic acid, -zinc salt	$C_4H_6N_2S_4Zn$	12122-67-7	CS2	630		
Ethyleneimine	C_2H_5N	151-56-4	MAS	--		
Ethylenethiourea	$C_3H_6N_2S$	96-45-7	HPLC	--		
bis(2-Ethylhexyl) phthalate	$C_{24}H_{38}O_4$	117-81-7	GCMS	1625	8270	
Fluoranthene	$C_{16}H_{10}$	206-44-0	GCMS	1625	8270	
Fluorene	$C_{13}H_{10}$	86-73-7	GCMS	1625	8270	
Fluorine	F_2	7782-41-4	--	--		
2-Fluoroacetamide	C_2H_4NFO	640-19-7	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Fluoroacetic acid, sodium salt	$C_2H_4FO_2Na$	62-74-8	HPLC	--		H
Formaldehyde	CH_2O	50-00-0	--	--		
Formic acid	CH_2O_2	64-18-6	--	--		
Formic acid, 2-(4-(5-nitro-2-furyl)-2-thiazolyl)hydrazide	$C_8H_6N_4O_4S$	3570-75-0	--	--		
(2,3,4-gh)Pyrrolizine-2,6(3H)dione, (4,5,8,10,12,13,13a,13b-octahydro-4,5-dishydroxy-3,4,5-trimethyl-2H-(1,6) dioxacycloundecino-	formula	315-22-0	--	--		
Glutarimide, 3-(2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl	$C_{15}H_{23}NO_4$	66-81-9	HPLC	--		
Glycidylaldehyde	$C_3H_4O_2$	765-34-4	--	--		H
Halomethane, NOS	CH_3X	1-19-3	GCMS	--		
Heptachlor	$C_{10}H_5Cl_7$	76-44-8	GCEC	608	8080	
Heptachlor epoxide	$C_{10}H_5Cl_7O$	1024-57-3	GCEC	608	8080	
Heptachlor epoxide (alpha, beta, and gamma isomers)	--	1-19-5	GCEC	608	8080	
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo, endo-dimethanonaphthalene	$C_{12}H_8Cl_6$	465-73-6	GCEC	608	8080	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Hexachlorobenzene	C_6H_6	118-74-1	GCMS	1625	8270	
Hexachlorobutadiene	C_4Cl_6	87-68-3	GCMS	1625	8270	
Hexachlorocyclohexane (all isomers)	$C_6H_6Cl_6$	608-73-1	GCEC	608	8080	
Hexachlorocyclopentadiene	C_5Cl_6	77-47-4	GCMS	1625	8270	
Hexachlorodibenzo-p-dioxins	$C_{12}H_2Cl_6O_2$	1-20-0	CLP	--		
Hexachlorodibenzofurans	$C_{12}H_2Cl_6O$	70-30-4	CLP	--		
Hexachloroethane	C_2Cl_6	67-72-1	GCMS	1625	8270	
Hexachlorophene	$C_{13}H_6Cl_6O_2$	70-30-4	HPLC	--		H
Hexachloropropene	C_3Cl_6	1888-71-7	MS-PROB	SRCH		
n-Hexacosane	$C_{26}H_{54}$	630-01-3	GCMS	1625	8270	
n-Hexadecane	$C_{16}H_{34}$	544-76-3	GCMS	1625	8270	
Hexaethyltetraphosphate	$C_{12}H_{30}O_{13}P$	757-58-4	HPLC	--		
2-Hexanone	$C_6H_{12}O$	591-78-6	GCMS	SRCH		
Hydantoin, 5,5-diphenyl-	$C_{15}H_{12}N_2O_2$	57-41-0	GCMS	SRCH		
Hydantoin, 5,5-diphenyl-monosodium salt	$C_{15}H_{12}N_2O_2 \cdot Na$	630-93-3	--	--		
Hydrazine	H_4N_2	302-01-2	HPLC	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Hydrocyanic acid	CHN	74-90-8	--	--		
Hydrofluoric acid	HF	7664-39-3	WET	--		
Hydrogen sulfide	H_2S	7783-06-4	WET	--		
Hydroquinone	$C_6H_6O_2$	123-31-9	--	--		
Hydroxydimethylarsine oxide	$C_2H_7AsO_2$	75-60-5	HPLC	--		
N-(2-hydroxyethyl)ethyleneimine	C_4H_9NO	1072-52-2	HPLC	--		
Hydroxylamine, N-nitroso-N-phenyl-, ammonium salt	$C_6H_6N_2O_2 \cdot H_3N$	135-20-6	HPLC	--		
Hypochlorous acid, calcium salt	Cl_2O_2Ca	7778-54-3	WET	--		H
Hypochlorous acid, sodium salt	ClONa	7681-52-9	--	--		H
2-Imidazolidinone, 1-(5-nitro-2-thiazolyl)-	$C_6H_6N_4O_3S$	61-57-4	HPLC	--		
Indeno(1,2,3-cd)pyrene	$C_{22}H_{12}$	193-39-5	GCMS	1625	8270	
Iodomethane	CH_3I	74-88-4	GCMS	SRCH		
Iron-dextran complex	Unknown	9004-66-4	ICP	--	6010	
Isobutyl alcohol	$C_4H_{10}O$	78-83-1	GCMS	SRCH		
Isocyanic acid, methyl ester	C_2H_3NO	624-83-9	--	--		H

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Isonicotinic acid hydrazide	$C_6H_7N_3O$	54-85-3	--	--		
Isophorone	$C_9H_{14}O$	78-59-1	--	--		
2-Isopropylnaphthalene	$C_{13}H_{14}$	2027-17-0	GCMS	SRCH		
Isosafrole	$C_{10}H_{10}O_2$	120-58-1	MS-PROB	SRCH		
Kepone	$C_{10}H_{10}O$	143-50-0	MS-PROB	SRCH		
Ketene	C_2H_2O	463-51-4	--	--		
Lasiocarpine	$C_{21}H_{33}O_7$	303-34-4	HPLC	--		
Lead	Pb	7439-92-1	FURN-AA	--	7421	
Lead acetate	$C_4H_6O_4Pb$	301-04-2	FURN-AA	--	7421	
Lead phosphate	O_4P_2Pb	7446-27-7	FURN-AA	--	7421	
Lead subacetate	$C_4H_{10}O_8Pb_3$	1335-32-6	FURN-AA	--	7421	
Lithium	Li	7439-93-2	ICP	--	6010	
Longifolene	$C_{15}H_{24}$	475-20-7	GCMS	SRCH		
Maleic anhydride	$C_4H_2O_3$	108-31-6	--	--		H
Maleic hydrazide	$C_4H_4N_2O_2$	123-33-1	HPLC	--		
Malononitrile	$C_3H_2N_2$	109-77-3	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Melphalan	$C_{13}H_{18}N_2Cl_2O_2$	148-82-3	HPLC	--		
Mercury	Hg	7439-97-6	CV-AA	--	7440	
Mercury fulminate	$C_2N_2O_2Hg$	628-86-4	CV-AA	--	7440	
Methacrylonitrile	C_4H_5N	126-98-7	MAS	SRCH		
Methanethiol	CH_4S	74-93-1	GCMS	SRCH		
Methapyrilene	$C_{14}H_{19}N_3S$	91-80-5	GCMS	SRCH		
1,3,4-Metheno-1H-cyclobuta[cd] pentalene, 1,1a,2,2,3,3a,4,5,5,5a, 5b,6,-dodecachlorooctahydro-	$C_{10}Cl_{12}$	2385-85-5	GCEC	617		
Methomyl	$C_5H_{10}N_2O_2S$	16752-77-5	HPLC-UV	632		
Methoxychlor	$C_{16}H_{15}Cl_3O_2$	72-43-5	GCEC	608	8080	
Methyl hydrazine	CH_4N_2	60-34-4	HPLC	--		
Methyl methacrylate	$C_5H_8O_2$	80-62-6	GCMS	SRCH		
Methyl methanesulfonate	$C_2H_6O_3S$	66-27-3	MS-PROB	SRCH		
Methyl parathion	$C_8H_{10}NO_5PS$	298-00-0	GC-NPD	622		
2-Methyl-2-(methylthio)propion-aldehyde-O-(methylcarbonyl) oxime	$C_7H_{14}N_2O_2S$	116-06-3	GC-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
4-Methyl-2-pentanone	$C_6H_{12}O$	108-10-1	GCMS	SRCH		
N-Methyl-N'-nitro-N-Nitrosoguanidine	$C_2H_5N_5O_3$	70-25-7	HPLC	--		
2-Methylaziridine	C_3H_7N	75-55-8	MAS	SRCH		
2-Methylbenzothioazole	C_8H_7NS	120-75-2	GCMS	SRCH		
Methylchlorocarbonate	$C_2H_3ClO_2$	79-22-1	--	--		
3-Methylcholanthrene	$C_{21}H_{16}$	56-49-5	GCMS	SRCH		
Methylene chloride	CH_2Cl_2	75-09-2	GCMS	1624	8240	
4,5-Methylene phenanthrene	$C_{15}H_{10}$	203-64-5	GCMS	SRCH		
4,4'-Methylene-bis(2-chloroaniline)	$C_{13}H_{12}Cl_2N_2$	101-14-4	GCMS	SRCH		
4-Methylfluorene	$C_{14}H_{12}$	1556-99-6	GCMS	SRCH		
1-Methylfluorene	$C_{14}H_{12}$	1730-37-6	GCMS	SRCH		
2-Methyllactonitrile	C_4H_7NO	75-86-5	--	--		H
2-Methylnaphthalene	$C_{11}H_{10}$	91-57-6	GCMS	SRCH		
1-Methylphenanthrene	$C_{15}H_{12}$	832-69-9	GCMS	SRCH		
9-Methylphenanthrene	$C_{15}H_{12}$	883-20-5	GCMS	SRCH		
2-(Methylthio)benzothiazole	$C_8H_7NS_2$	615-22-5	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Methylthiouracile	$C_5H_6N_2OS$	56-04-2	HPLC	--		
Mustard gas	$C_4H_8Cl_2S$	505-60-2	--	--		H
Naphthalene	$C_{10}H_8$	91-20-3	GCMS	1625	8270	
1,5-Naphthalenediamine	$C_{10}H_{10}N_2$	2243-62-1	MS-PROB	SRCH		
1,4-Naphthoquinone	$C_{10}H_6O_2$	130-15-4	MS-PROB	SRCH		
1,4-Naphthoquinone, 2,3-dichloro-	$C_8H_4Cl_2O_2$	117-80-6	GC-PROB	SRCH		
1-Naphthyl-2-thiourea	$C_{11}H_{10}N_2S$	86-88-4	HPLC	--		
beta-Naphthylamine	$C_{10}H_9N$	91-59-8	GCMS	1625	8270	
1-Naphthylamine	$C_{10}H_9N$	134-32-7	GCMS	SRCH		
Nickel	Ni	7440-02-0	ICP	--	6010	
Nickel carbonyl	C_4O_4Ni	13463-39-3	ICP	--	6010	
Nickel cyanide	C_2N_2Ni	557-19-7	ICP	--	6010	
Nicotine and salts, NOS	$C_{10}H_{14}N_2$	54-11-5	MS-PROB	SRCH		
Nicotine oxalate	$C_{10}H_{14}N_2 \cdot xC_2H_2O_4$	23758-42-1	--	--		H
Nitric oxide	NO	10102-43-9	--	--		
Nitrites	--	14797-65-0	WET	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
5-Nitro-o-toluidine	$C_7H_8N_2O_2$	99-55-8	GCMS	SRCH		
2-Nitroaniline	$C_6H_6N_2O_2$	88-74-4	GCMS	SRCH		
3-Nitroaniline	$C_6H_6N_2O_2$	99-09-2	GCMS	SRCH		
p-Nitroaniline	$C_6H_6N_2O_2$	100-01-6	GCMS	SRCH		
Nitrobenzene	$C_6H_5NO_2$	98-95-3	GCMS	1625	8270	
Nitrogen dioxide	NO_2	10102-44-0	--	--		H
Nitrogen mustard	$C_5H_{11}Cl_2N$	51-75-2	--	--		H
Nitrogen mustard and hydrochloride salt	$C_5H_{12}Cl_3N$	1-26-2	--	--		H
Nitrogen mustard N-oxide	$C_5H_{11}Cl_2NO$	126-85-2	MS-PROB	SRCH		
Nitrogen mustard N-oxide, hydrochloride salt	$C_5H_{12}Cl_3NO$	302-70-5	--	--		H
Nitroglycerin	$C_3H_5N_3O_9$	55-63-0	MAS	SRCH		
2-Nitrophenol	$C_6H_5NO_3$	88-75-5	GCMS	1625	8270	
4-Nitrophenol	$C_6H_5NO_3$	100-02-7	GCMS	1625	8270	
4-Nitroquinoline-1-oxide	$C_9H_6N_2O_3$	56-57-5	GCMS	SRCH		
Nitrosamine, NOS	--	35576-91-1	--	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
N-Nitroso-N-ethylurea	$C_3H_7N_3O_2$	759-73-9	HPLC	--		
N-Nitroso-N-methylurea	$C_2H_5N_3O_2$	684-93-5	HPLC	--		
N-Nitroso-N-methylurethane	$C_4H_8N_2O_3$	615-53-2	HPLC	--		
N-Nitrosodi-n-butylamine	$C_8H_{18}N_2O$	924-16-3	GCMS	SRCH		
N-Nitrosodiethanolamine	$C_4H_{10}N_2O_3$	1116-54-7	HPLC	--		
N-Nitrosodiethylamine	$C_4H_{10}N_2O$	55-18-5	GCMS	SRCH		
N-Nitrosodimethylamine	$C_2H_6N_2O$	62-75-9	GCMS	1625	8270	
N-Nitrosodiphenylamine	$C_{12}H_{10}N_2O$	86-30-6	GCMS	1625	8270	
N-Nitrosomethylethylamine	$C_3H_8N_2O$	10595-95-6	GCMS	SRCH		
N-Nitrosomethylphenylamine	$C_7H_8N_2O$	614-00-6	GCMS	SRCH		
N-Nitrosomethylvinylamine	$C_3H_6N_2O$	4549-40-0	HPLC	--		
N-Nitrosomorpholine	$C_4H_8N_2O_2$	59-89-2	HPLC	--		
N-Nitrosonornicotine	$C_9H_{11}N_3O$	16543-55-8	HPLC	--		
N-Nitrosopiperidine	$C_5H_{10}N_2O$	100-75-4	MS-PROB	SRCH		
N-Nitrososarcosine	$C_3H_6N_2O_3$	13256-22-9	HPLC	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
17-alpha-19-Norpregna-1,3,5(10)-trien-20-yn-17-ol, 3-methoxy-	$C_{21}H_{26}O_2$	72-33-3	MS-PROB	SRCH		
n-Octacosane	$C_{28}H_{58}$	630-02-4	GCMS	1625	8270	
n-Octadecane	$C_{18}H_{38}$	593-45-3	GCMS	1625	8270	
Octamethylpyrophosphoramide	$C_8H_{24}N_4O_3P_2$	152-16-9	HPLC	--		
Osmium tetroxide	O_4Os	20816-12-0	ICP	--	6010	
7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid	$C_8H_{10}O_5$	145-73-3	GC-PROB	SRCH		
2-Oxetanone	$C_3H_4O_2$	57-57-8	MS-PROB	SRCH		H
4,4'-Oxydianiline	$C_{12}H_{14}N_2O$	101-80-4	--	--		H
Paraldehyde	$C_6H_{12}O_3$	123-63-7	--	--		H
Parathion	$C_{10}H_{14}NO_5PS$	56-38-2	GCNPD	614	8140	
PCB-1016	--	12674-11-2	GCEC	608	8080	
PCB-1221	--	11104-28-2	GCEC	608	8080	
PCB-1232	--	11141-16-5	GCEC	608	8080	
PCB-1242	--	53469-21-9	GCEC	608	8080	
PCB-1248	--	12672-29-6	GCEC	608	8080	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
PCB-1254	--	11097-69-1	GCEC	608	8080	
PCB-1260	--	11096-82-5	GCEC	608	8080	
Pentachlorobenzene	C_6HCl_5	608-93-5	MS-PROB	SRCH		
Pentachlorodibenzo-p-dioxins	$C_{12}H_3O_2Cl_5$	1-28-9	DIOXIN	CLP	8280	
Pentachlorodibenzofurans	$C_{12}H_3OCl_5$	1-29-0	DIOXIN	CLP	8280	
Pentachloroethane	C_2HCl_5	76-01-7	GCMS	SRCH		
Pentachloronitrobenzene	$C_6NO_2Cl_5$	82-68-8	GCEC	617		
Pentachlorophenol	C_6HOCl_5	87-86-5	GCMS	1625	8270	
Pentafluorobenzene	C_6HF_5	363-72-4	MS-PROB	SRCH		
Pentafluorobromobenzene	C_6BrF_5	344-04-7	MS-PROB	SRCH		
Pentamethylbenzene	$C_{11}H_{16}$	700-12-9	GCMS	SRCH		
Peroxyacetic acid	$C_2H_4O_3$	79-21-0	--	--		H
Perylene	$C_{20}H_{12}$	198-55-0	GCMS	SRCH		
Phenacetin	$C_{10}H_{13}NO_2$	62-44-2	MS-PROB	SRCH		
Phenanthrene	$C_{14}H_{10}$	85-01-8	GCMS	1625	8270	
Phenol	C_6H_6O	108-95-2	GCMS	1625	8270	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Phenothiazine	C_9H_7NOS	92-84-2	GCMS	SRCH		
Phenylenediamine	$C_6H_8N_2$	1-29-6	--	--		
o-Phenylenediamine	$C_6H_8N_2$	95-54-5	MS-PROB	SRCH		
P-Phenylenediamine	$C_6H_8N_2$	106-50-3	GCMS	SRCH		
m-Phenylenediamine	$C_6H_8N_2$	108-45-2	MS-PROB	SRCH		
o-Phenylenediamine, 4-chloro-	$C_6H_7N_2Cl$	95-83-0	GCMS	SRCH		
m-Phenylenediamine,4-methoxy-, sulfate	$C_7H_{12}N_2O_5S$	39156-41-7	--	--		H
Phenylmercury acetate	$C_8H_8HgO_2$	62-38-4	CV-AA	--	7440	
1-Phenylnaphthalene	$C_{16}H_{12}$	605-02-7	GCMS	SRCH		
2-Phenylnaphthalene	$C_{16}H_{12}$	612-94-2	GCMS	SRCH		
N-Phenylthiourea	$C_7H_8N_2S$	1103-85-5	HPLC	--		
Phosgene	CCl_2O	75-44-5	--	--		H
Phosphine	H_3P	7803-51-2	WET	--		
Phosphoramidothioic acid, acetamidoyl, O,O-bis(p-chlorophenyl) ester	$C_{14}H_{13}Cl_2N_2O_2PS$	4104-14-7	MS-PROB	SRCH		
Phosphoric acid, (2,2,2-trichloro-1-hydroxyethyl)-, dimethyl ester	$C_4H_8O_4Cl_3P$	52-68-6	GC-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Phosphoric acid, 1,2-dibromo-2,2-dichloroethyl dimethyl ester	$C_4H_7O_3Br_2Cl_2P$	300-76-5	GC-NPD	622		
Phosphoric acid, 2,2-dichlorovinyl dimethyl ester	$C_4H_7O_3Cl_2P$	62-73-7	GC-NPD	622		
Phosphoric acid, 2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl ester	$C_{10}H_9O_3Cl_4P$	911-11-5	GC-NPD	622		
Phosphoric acid, 2-chloro-1-2(2,4-dichlorophenyl)vinyl dimethyl ester	$C_{10}H_{10}O_3Cl_3P$	470-90-6	GC-PROB	SRCH		
Phosphoric acid, dimethyl ester, ester with (E)-3-hydroxy-N,N- dimethyl-crotonamide	$C_8H_{16}NO_5P$	141-66-2	GC-PROB	SRCH		
Phosphoric acid, dimethyl ester, ester with (E)-3-hydroxy-N-methylcrotonamide	$C_7H_{14}NO_5P$	6923-22-4	GC-PROB	SRCH		
Phosphoric acid, dimethyl ester, ester with 2-chloro-N-N-diethyl- 3-hydroxycrotonamide	$C_{10}H_{19}NO_5ClP$	13171-21-6	GC-PROB	SRCH		
Phosphoric acid, tri-o-tolyl ester	$C_{21}H_{21}O_4P$	78-38-8	MS-PROB	SRCH		
Phosphoric acid, trimethyl ester	$C_3H_8O_4P$	512-56-1	MS-PROB	SRCH		
Phosphoric acid, hexamethyl-	$C_6H_{12}N_3OP$	680-31-9	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Phosphorodithioic acid, O,O-diethyl ester, S-ester with 3-(mercapto-methyl)-1,2,3-benzotriazin-4(3H)-one	$C_{12}H_{16}N_3O_3PS_2$	2642-71-9	GC-PROB	SRCH		
Phosphorodithioic acid, O-O-diethyl O-(2-(ethylthio)ethyl) ester mixed with O,O-diethyl S-(2-(ethylthio) ethyl) ester (7:3)	$C_8H_{19}O_3PS_2$	8065-48-3	GC-NPD	622		
Phosphorodithioic acid, O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) ester	$C_{12}H_{21}N_2O_3PS$	333-41-5	GC-NPD	622		
Phosphorodithioic acid, O,O-diethyl O-(3,5,6-trichloro-2-pryidyl) ester	$C_{10}H_{11}NO_3C_3PS$	2921-88-2	GC-NPD	622		
Phosphorodithioic acid, O,O-diethyl O-(p-(methysulfinyl)phenyl ester	$C_{11}H_{17}O_4PS_2$	115-90-2	GC-NPD	622		
Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester (phorate)	$C_7H_{17}O_2PS_3$	298-02-2	GC-NPD	622		
Phosphorodithioic acid, O,O-diethyl-S-[(1,1-dimethylethyl)thio] methyl ester	$C_9H_{21}O_2PS_3$	13071-79-9	--	--		
Phosphorodithioic acid, O,O-dimethyl ester, S-ester with 3-(mercaptomethyl)-1,2,3-benzotriazin-4(3H)-one	$C_{10}H_{12}N_3O_3PS_2$	86-50-0	GC-NPD	622		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Phosphorodithioic acid, O,O-dimethyl ester, S-ester with N-(mercaptomethyl) phthalimide	$C_{11}H_{12}NO_4PS_2$	732-11-6	GC-PROB	SRCH		
Phosphorodithioic acid, O,O-dimethyl-, O-(4-methhthio)-m-tolyl) ester	$C_{10}H_{15}O_3PS_2$	55-38-9	GC-NPD	622		
Phosphorodithioic acid,s(((p-chloro-phenylthio)methyl) O,O-diethyl ester	$C_{11}H_{16}O_2PS_3$	786-19-6	GCEC	617		
Phosphorodithioic acid, S,S'-methylene O,O,O',O'-tetraethyl ester	$C_9H_{22}O_4P_2S_4$	563-12-2	GC-NPD	614	8140	
Phosphorodithioic acid, S,S'-p-dioxane-2,3-dryl O,O,O',O'-tetraethyl ester	$C_{12}H_{26}O_6P_2S_4$	78-34-2	GC-NPD	701		
Phosphorodithioic acid, S-(2-(ethyl-sulfinyl)ethyl) O,O-dimethyl ester	$C_6H_{15}O_4S_2P$	301-12-2	GCMS	SRCH		
Phosphorothioic acid, O,O-dimethyl O-[p-[(ddimethylamino)sulfonyl) phenyl] ester	$C_{10}H_{16}NO_5PS_2$	52-85-7	GC-PROB	SRCH		
Phosphorothioic acid, phenyl, O-(4-bromo-2,5-dichlorophenyl) O-methyl ester	$C_{13}H_{10}O_2Cl_2BrPS$	21609-90-5	--	--		
Phosphorothioic acid, phenyl-, O-ethyl O-(p-nitrophenyl) ester	$C_{14}H_{14}NO_2PS$	2104-64-5	--	--		
Phthalic acid esters, NOS	--	1-30-3	GCMS	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Phthalic anhydride	$C_8H_4O_3$	85-44-9	--	--		H
2-Picoline	C_8H_7N	109-06-8	GCMS	1625	8270	
Polybrominated biphenyls, NOS	--	59536-65-1	GCMS	SRCH		
Polychlorinated biphenyl, NOS	--	1-30-6	GCEC	608	8080	
Polychlorinated biphenyl, NOS	--	1336-36-3	GCEC	608	8080	
Potassium cyanide	CNK	151-50-8	WET	--		
Potassium silver cyanide	C_2N_2AgK	506-61-6	ICP	--	6010	
Pronamide	$C_{12}H_{11}KNOCl_2$	23950-58-5	GCMS	SRCH		
1,3-Propane sulfone	$C_3H_6O_3S$	1120-71-4	--	--		H
2-Propanone	C_3H_6O	67-64-1	GCMS	1624	8240	
Propionitrile, 2-hydroxy-	C_3H_5NO	78-97-7	--	--		
n-Propylamine	C_3H_9N	107-10-8	MAS	SRCH		
2-Propyn-1-ol	C_3H_4O	107-19-7	MAS	SRCH		
Pyrene	$C_{16}H_{10}$	129-00-0	GCMS	1625	8270	
Pyridine	C_5H_5N	110-86-1	MS-PROB	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Pyridine, 2,6-diamino-3-(phenylazo)-, monohydrochloride	$C_{12}H_{12}N_5Cl$	136-40-3	--	--		H
Pyridine, 3-chloromethyl-, hydrochloride	$C_6H_7NCl_2$	6959-48-4	--	--		H
Reserpine	$C_{33}H_{40}N_2O_9$	50-55-5	HPLC-UV	--		
Resorcinol	$C_6H_6O_2$	108-46-3	HPLC	--		
Saccharin and salts	$C_7H_5NO_3S$	81-07-2	HPLC	--		
Safrole	$C_{10}H_{10}O_2$	04-59-7	MS-PROB	SRCH		
Salicylanilide, 2'5-dichloro-4'-nitro, compound with 2-aminoethanol (1:1)	$C_{15}H_{14}N_3O_5Cl_2$	14200-40-8	MS-PROB	SRCH		
Selenious acid	H_2O_3Se	7783-00-8	FURN-AA	--	7740	
Selenium	Se	7782-49-2	FURN-AA	--	7740	
Selenium sulfide (SeS)	SSe	7446-34-6	FURN-AA	--	7740	
Selenium sulfide (SeS2)	S_2Se	7488-56-4	FURN-AA	--	7740	
Selenourea	CH_4N_2Se	630-10-4	FURN-AA	--	7740	
Semicarbazide	CH_5N_3O	57-56-7	--	--		
Silver	Ag	7440-22-4	ICP	--	6010	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Silver cyanide	AgCN	506-64-9	ICP	--	6010	
Sodium cyanide	NaCN	143-33-9	WET	--		
Sodium salt, dihydrate (of saccharin)	$C_7H_5NO_3S \cdot 2H_2O \cdot Na$	6155-57-3	--	--		
Squalene	$C_{30}H_{50}$	7683-64-9	GCMS	SRCH		
Streptozotocin	$C_8H_{15}N_3O_7$	18883-66-4	HPLC	--		
Strontium sulfide	SSr	1314-96-1	ICP		6010	
Strychnine and salts	$C_{21}H_{22}N_2O_2$	57-24-9	GCMS	SRCH		
Styrene	C_8H_8	100-42-5	GCMS	1625	8270	
Succinic acid, mercapto-, diethyl ester, S-ester with O,O-dimethyl phosphorodithioate	$C_{10}H_{19}O_6PS_2$	121-75-5	PEST	614	8140	
Sulfuric acid, diethyl ester	$C_4H_5O_4S$	64-67-5	--	--		H
alpha-Terpineol	$C_{10}H$	98-55-5	GCMS	1625	8270	
Tetrachloroethene	C_2H_4	127-18-4	GCMS	1624	8240	
1,2,4,5-Tetrachlorobenzene	$C_6H_2Cl_4$	95-94-3	GCMS	SRCH		
1,2,3,4-Tetrachlorobenzene	$C_6H_2Cl_4$	634-66-2	GCMS	SRCH		
1,2,3,5-Tetrachlorobenzene	$C_6H_2Cl_4$	634-90-2	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
2,3,7,8-Tetrachlorodibenzo-p-dioxin	$C_{12}H_4Cl_4O_2$	1746-01-6	DIOXIN	613	8280	
Tetrachlorodibenzo-p-dioxins	$C_{12}H_4Cl_4O_2$	1-33-1	DIOXIN	CLP	8280	
Tetrachlorodibenzofurans	$C_{12}H_4Cl_4O$	1-33-2	DIOXIN	CLP	8280	
1,1,2,2-Tetrachloroethane	$C_2H_2Cl_4$	79-34-5	GCMS	1624	8240	
1,1,1,2-Tetrachloroethane	$C_2H_2Cl_4$	630-30-6	GCMS	SRCH		
Tetrachloroethane, NOS	$C_2H_2Cl_4$	25322-20-7	GCMS	SRCH		
Tetrachloromethane	CCl_4	56-23-5	GCMS	1624	8240	
2,3,5,6-Tetrachloronitrobenzene	$C_6HNO_2Cl_4$	117-18-0	MS-PROB	SRCH		
2,3,4,6-Tetrachlorophenol	$C_6H_2OCl_4$	58-90-2	GCMS	SRCH		
2,3,5,6-Tetrachlorophenol	$C_6H_2OCl_4$	935-95-5	GCMS	SRCH		
2,3,4,5-Tetrachlorophenol	$C_6H_2OCl_4$	4901-51-3	GCMS	SRCH		
n-Tetracosane	$C_{24}H_{50}$	646-31-1	GCMS	1625	8270	
n-Tetradecane	$C_{14}H_{30}$	629-59-4	GCMS	1625	8270	
Tetraethyl lead	$C_8H_{20}Pb$	78-00-2	FURN-AA	--	7421	
Tetraethyldithiopyrophosphate	$C_8H_{20}O_5P_2S_2$	3689-24-5	GC-PROB	SRCH		
Tetraethylpyrophosphate	$C_8H_{20}O_7P_2$	107-49-3	HPLC	--		H

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Tetramethyl lead	$C_4H_{12}Pb$	75-74-1	FURN-AA	--	7421	
Tetranitromethane	CN_4O_8	509-14-8	--	--		
Thallic oxide	O_3Tl_2	1314-32-5	ICP	--	6010	
Thallium	Tl	7440-28-0	FURN-AA	--	7841	
Thallium selenite	SeTl	12039-52-0	FURN-AA	--	7841	
Thallium(I)acetate	$C_2H_4O_2 \cdot Tl$	563-68-8	FURN-AA	--	7841	
Thallium(I)carbonate	CO_3Tl_2	6533-73-9	FURN-AA	--	7841	
Thallium(I)chloride	ClTl	7791-12-0	FURN-AA	--	7841	
Thallium(I)nitrate	NO_3Tl	10102-45-1	FURN-AA	--	7841	
Thallium(I)sulfate	O_4STl_2	10031-59-1	FURN-AA	--	7841	
Thianaphthene	C_8H_6S	95-15-8	GCMS	SRCH		
Thioacetamide	C_2H_5NS	62-55-5	--	--		H
Thiosemicarbazide	CH_5N_3S	79-19-6	HPLC	--		
Thiourea	CH_2N_2S	62-56-66	HPLC	--		
Thioxanthen-9-one	$C_{13}H_8O_5$	492-22-8	GCMS	SRCH		
Thiram	$C_6H_{12}N_2S_4$	137-26-8	CS2	630		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Toluene	C_7H_8	108-88-3	GCMS	1624	8240	
Toluene diamine	$C_7H_{10}N_2$	25376-45-8	--	--		
Toluene, 2,4-diamino-	$C_7H_{10}N_2$	95-80-7	GCMS	SRCH		
3,4-Toluenediamine	$C_7H_{10}N_2$	496-72-0	GCMS	SRCH		
o-Toluidine	C_7H_9N	95-53-4	MS-PROB	SRCH		
o-Toluidine hydrochloride	$C_7H_{10}NCl$	636-21-5	MS-PROB	SRCH		
o-Toluidine, 4-(o-tolylazo)-	$C_{14}H_{15}N_3$	97-56-3	MS-PROB	SRCH		
o-Toluidine, 5-chloro-	C_7H_8NCl	95-79-4	MS-PROB	SRCH		
p-Toluidine, alpha, alpha, alpha-trifluoro-2,6-dinitro-N,N-dipropyl-	$C_{13}H_{16}N_3O_4F_3$	1582-09-8	GCEC	617		
p-Toluidine, N-(2-chloroethyl)-2,6-dinitro-N-propyl-alpha,alpha, alpha-trifluoro-	$C_{12}H_{13}N_3O_4ClF_3$	33245-39-5	--	--		
Tolylene diisocyanate	$C_9H_6N_2O_2$	26471-62-5	--	--		H
Total xylenes	C_8H_{10}	3-25-0	GCMS	SRCH		
Toxaphene	$C_{10}H_{10}Cl_8$	8001-35-2	GCEC	608	8080	
n-Triacontane	$C_{30}H_{62}$	638-68-6	GCMS	1625	8270	

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Triazene, 3,3-dimethyl-1-(p-chloro-phenyl)-	$C_8H_{10}ClN_3$	7203-90-0	--	--		
S-Triazine, 2,4-dichloro-6-(o-chloro-anilino	$C_9H_5N_3C_3$	101-05-3	GC-PROB	SRCH		
Tribromomethane	$CHBr_3$	75-25-2	GCMS	1624	8240	
1,1,2-Trichloro-2-fluoroethane	$C_2H_2Cl_3F$	359-28-4	GCMS	SRCH		
1,2,3-Trichlorobenzene	$C_6H_3Cl_3$	87-61-6	GCMS	1625	8270	
1,3,5-Trichlorobenzene	$C_6H_3Cl_3$	108-70-3	GCMS	SRCH		
1,2,4-Trichlorobenzene	$C_6H_3Cl_3$	120-82-1	GCMS	1625	8270	
1,1,1-Trichloroethane	$C_2H_3Cl_3$	71-55-6	GCMS	1624	8240	
1,1,2-Trichloroethane	$C_2H_3Cl_3$	79-00-5	GCMS	1624	8240	
Trichloroethene	C_2HCl_3	79-01-6	GCMS	1624	8240	
Trichloromethanethiol	$CHCl_3S$	75-07-7	GCMS	SRCH		
Trichloromonofluoromethane	CCl_3F	75-69-4	GCMS	SRCH		
2,4,6-Trichlorophenol	$C_6H_3Cl_3O$	88-06-2	GCMS	1625	8270	
2,4,5-Trichlorophenol	$C_6H_3Cl_3O$	95-95-4	GCMS	1625	8270	
2,3,6-Trichlorophenol	$C_6H_3Cl_3O$	933-75-5	GCMS	SRCH		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
2,3,4-Trichlorophenol	$C_6H_3Cl_3O$	15950-66-0	GCMS	SRCH		
2,4,5-Trichlorophenoxyacetic acid	$C_8H_5Cl_3O_3$	93-76-5	GCEC	615	8150	
2,4,5-Trichlorophenoxypropionic acid	$C_9H_7Cl_3O_3$	93-72-1	GCEC	615	8150	
1,2,3-Trichloropropane	$C_3H_5Cl_3$	96-18-4	GCMS	SRCH		
Trichloropropane, NOS	$C_3H_5Cl_3$	1-37-1	GCMS	--		
O,O,O-Triethylphosphorothioate	$C_6H_{15}O_3PS$	126-68-1	MS-PROB	SRCH		
3,4,5-Trimethoxybenzaldehyde	$C_{10}H_{12}O_4$	86-81-7	GCMS	SRCH		
1,2,3-Trimethoxybenzene	$C_9H_{12}O_3$	634-36-6	GCMS	SRCH		
sym-Trinitrobenzene	$C_6H_3N_3O_6$	99-35-4	HPLC	--		
Triphenylene	$C_{18}H_{12}$	217-59-4	GCMS	SRCH		
Tripropyleneglycol methyl ether	$C_{10}H_{21}O_3$	20324-33-8	GCMS	SRCH		
Tris(1-azridinyl)phosphine sulfide	$C_6N_{12}N_3PS$	52-24-4	HPLC	--		
Tris(2,3-dibromopropyl)phosphate	$C_9H_{15}O_4Br_6P$	126-72-7	MS-PROB	SRCH		
1,3,5-Trithiane	$C_3H_6S_3$	291-21-4	GCMS	SRCH		
Trypan blue	$C_{34}H_{24}N_6O_{14}S_4Na_4$	72-57-1	HPLC	--		
Uracil mustard	$C_8H_{11}Cl_2N_3O_2$	66-75-1	HPLC	--		

Table A.1 ITD/RCRA COMPOUND DATA (Continued)

Name in Regulation	Empirical Formula	CAS Number	Analysis Type	Analysis Method	RCRA Method	Other
Urea, 1-ethyl-3-(5-nitro-2-thiazolyl)-	$C_7H_{10}N_2O_3S$	51-52-5	HPLC	--		
Vanadic acid (ammonium salt of)	$H_4N{\cdot}O_3V$	7803-55-6	ICP	--	6010	
Vanadium pentoxide	O_5V_2	1314-62-1	GCMS	SRCH		
Vinyl acetate	$C_4H_6O_2$	108-05-4	GCMS	SRCH		
Vinyl chloride	C_2H_3Cl	75-01-4	GCMS	1624	8240	
Warfarin (potassium salt)	$C_{19}H_{16}O_4K$	2160-86-8	--	--		H
Zinc	Zn	7440-66-6	ICP	--	6010	
Zinc bis(dimethyldithiocarbamato)-	$C_6H_{12}N_2S_4Zn$	137-30-4	CS2	630		
Zinc cyanide	C_2N_2Zn	557-21-1	ICP	--	6010	
Zinc phosphide	P_2Zn_3	1314-84-7	ICP	--	6010	
Zinc phosphide	P_2Zn	12037-79-5	ICP	--	6010	